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Report of the Arctic Fisheries Scientific Advisory Committee for 1989/90 and 1990/91

R.A. Bodaly, S.E. Cosens,
T.A. Shortt and R.E.A. Stewart

Central and Arctic Region
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REPORT OF THE ARCTIC FISHERIES SCIENTIFIC ADVISORY COMMITTEE FOR 1989/90 AND 1990/91

by

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ABSTRACT

Bodaly, R.A., S.E. Cosens, T.A. Shortt, and R.E.A. Stewart. 1992. Report of the Arctic Fisheries Scientific Advisory Committee for 1989/90 and 1990/91. Can. Manuscr. Rep. Fish. Aquat. Sci. 2139: iv + 91 p.

The Arctic Fisheries Scientific Advisory Committee (AFSAC) was established in November 1985 to develop and provide scientifically sound advice for stocks of fish and marine mammals in the Northwest Territories, Yukon north slope and other territorial waters manager by the Central and Arctic Region of the Department of Fisheries and Oceans. AFSAC is comprised of a Chairperson, Executive Committee, Fish Subcommittee and marine Mammals Subcommittee; operates on the peer review principle; reports to the Regional Director, Science, and advises the Regional Director General and Regional Director, Fisheries and Habitat Management. In 1989/90 and 1990/91, AFSAC reviewed and developed advice on 11 fish stocks/stock complexes, annual commercial quotas for Arctic charr in the NWT and six marine mammal stocks. AFSAC also produced a framework for management and research recommendations by the Marine Mammal Subcommittee and recommendations for future Arctic charr research in the Canadian Arctic.

Key words: Arctic zone; fish; management; marine mammals; research; stocks.

RÉSUMÉ

Bodaly, R.A., S.E. Cosens, T.A. Shortt and R.E.A. Stewart. 1992. Report of the Arctic Fisheries Scientific Advisory Committee for 1989/90 and 1990/91. Can. Manuscr. Rep. Fish. Aquat. Sci. 2139: iv + 91 p.

Le Comité scientifique consultatif des pêches canadiennes dans l'Arctique (CSCPCA) a été créé en novembre 1985 dans le but d'étudier de manière rigoureusement scientifique les stocks de poissons et de mammifères marins des Territoires du Nord-Ouest, du versant nord du Yukon et des eaux territoriales gérées par la Région du Centre et de l'Arctique. Le CSCPCA est composé d'un président, d'un comité exécutif, d'un sous-comité des poissons et d'un sous-comité des mammifères marins; il fonctionne selon le principe de révision par les pairs, rend compte de ses activités au Directeur régional des sciences et conseille le Directeur général régional et le Directeur régional du service de Gestion des pêches et de l'habitat. En 1989-1990, le CSCPCA a examiné onze complexes stocks de poissons et six stocks de mammifères marins ainsi que sur les quotas commerciaux annuels de l'omble chevalier, et fait des recommendations à leur égard. Le CSCPCA a de même produit un cadre gestionnaire et recherche des recommendations par le sous-comité des mammifères marins et des recommandations pour recherche future de l'omble chevalier de l'arctique Canadien.

Mots-clés: zone de l'Arctique; poisson; gestion; mammifères marins; programmes de recherche; stocks.

OVERVIEW OF THE ARCTIC FISHERIES SCIENTIFIC ADVISORY COMMITTEE: 1989/90 AND 1990/91

INTRODUCTION

Since its establishment as a regional scientific advisory body in November, 1985, the Arctic Fisheries Scientific Advisory Committee (AFSAC) has provided management advice and research recommendations on a large number of Arctic species and stocks (See Appendix 2). AFSAC's main objective, as originally described in 1985, continues to be to provide sound biological advice to Fisheries Management (the Regional Director General and Regional Director of Fisheries and Habitat Management for the Central and Arctic Region) on Arctic fish and marine mammal stocks so that management decisions result in the long-term well-being of these stocks. AFSAC has provided advice to fishery management boards and to Departmental fishery managers to guide in the formulation of management decisions. Using a peer review principle, AFSAC ensures the scientific quality and biological soundness of the advice which it provides.

In addition to management advice, AFSAC identifies, for Science managers, research requirements for the various stocks/species for which the Department is responsible in the Canadian Arctic.

According to the Terms of Reference and Operating Procedures April, 1987, the specific responsibilities of AFSAC are:

a) to assess the status of fish and marine mammal stocks and to make biologically sound recommendations on harvest levels;

b) to assess other biological aspects of management (such as size restrictions, closed seasons, mesh size, etc.) and to make biologically sound recommendations on such operational requirements for management;

c) to assess the adequacy of biological information available for making fisheries management decisions and to make recommendations for its extension or improvement;

d) to review and assess biological aspects of general management plans for fish and marine mammals; and

e) to respond to any other request for biological advice on fisheries management and habitat issues from the Director General, Regional Director of Fisheries and Habitat Management, Regional Director of Science, or Director of Biological Sciences, Central and Arctic Region, as may from time to time arise.

In 1988 new terms of reference were prepared to provide an expanded scope for AFSAC. While some provisions, such as the establishment of an AFSAC coordinator based in Winnipeg, and increased involvement of AFSAC in Arctic management issues of concern to the Quebec Region, have been put into effect, the new terms of reference are still under review and revision.

To aid its work, AFSAC commissions the preparation of background reports on specific topics; these are internal working documents solely for the use of AFSAC members. A schedule for review of important fish and marine mammal stocks is established in consultation with the Regional Director, Fisheries and Habitat Management and the Director, Biological Sciences. The proposed schedule for 1991/92 and 1992/93 which includes the names of suggested authors of background reports is provided as Table 2.

AFSAC MEMBERSHIP

AFSAC discharges its responsibilities through the activities of its Chairperson, Coordinator, Executive Committee, Fish Subcommittee and Marine Mammals Subcommittee. The majority of members are from the Central and Arctic Region, Department of Fisheries and Oceans (DFO), but the Quebec Region, DFO, was represented on all committees in 1989/90 and 1990/91. The membership of AFSAC during 1989/90 and 1990/91 was:

Executive Committee:

R. McV. Clarke (Pacific and Freshwater Fisheries (P&FF) Central and Arctic Region)

T. Shortt	(Science, Central and Arctic Region) AFSAC Coordinator and Acting Chairperson
A. Mansfield	(Science, Quebec Region)
S. Cosens	(Science, Central and Arctic Region) 01/04/89 - 01/02/91
J. Craig	(Science, Central and Arctic Region) 01/04/89 - 01/02/90
D. Bodaly	(Science, Central and Arctic Region) replaced J. Craig - 01/02/90
M. Papst	(Science, Central and Arctic Region) 02/02/90 - 31/03/90
R. Stewart	(Science, Central and Arctic Region) replaced S. Cosens 01/02/91 - 31/03/91

Fish Subcommittee:

D. Bodaly	(Science, Central and Arctic Region) Chairperson commencing 02/02/90
J. Craig	(Science, Central and Arctic Region) Chairperson 01/04/89 - 01/02/90
A. Kristofferson	(F&HM, Central and Arctic Region)
J. Reist	(Science, Central and Arctic Region)

R. Crawford	Science, Central and Arctic Region)
L. Johnson	(Science, Central and Arctic Region) 01/04/89 - 31/12/89
J. Flannagan	(Science, Central and Arctic Region) commencing 20/02/90
C. Hudon	(Science, Quebec Region) 01/04/89 - 01/03/90
R. Morin	(Science, Quebec Region) commencing 01/03/90

Marine Mammals Subcommitte:

S. Cosens	(Science, Central and Arctic Region) Chairperson 01/04/89
S. Innes	(Science, Central and Arctic Region)
P. Richard	(F&HM, Central and Arctic Region)
T. Strong	(F&HM, Central and Arctic Region)
M. Kingsley	(Science, Quebec Region) 01/04/89 - 11/09/89
T. Smith	(Science, Quebec Region) commencing 11/09/89
R. Stewart	(Science, Central and Arctic Region) Acting Chairperson 01/02/91 - 31/03/91
H. Cleator	(Science, Central and Arctic Region) commencing 01/02/91

During 1989/90 and 1990/91 a number of changes were made to the AFSAC committees. Dr. J. Craig vacated his position as chair of the Fish Subcommittee when he left DFO on a leave of absence in February, 1990. He was replaced by D. Bodaly, an existing member of the Fish Subcommittee. Dr. J. Flannagan was appointed as a member of the Subcommittee to replace Dr. Craig. C. Hudon, member of the Subcommittee representing the Quebec Region left that Region for a position in the Scotia-Fundy Region. She was replaced on the Subcommittee by R. Morin of Science in the Quebec Region.

Membership of the Marine Mammal Subcommittee also underwent some changes with the resignation of Dr. M. Kingsley, the Quebec Science representative, in September, 1990. His replacement was Dr. T. Smith, also of Science, in the Quebec Region. In FY 1990/91, S. Cosens left for maternity leave in February, 1991, and R. Stewart replaced her as chair for the 1990/91 meeting of the Subcommittee. H. Cleator was appointed to the Subcommittee in February, 1991.

The Executive Committee membership underwent some changes as well. At the start of the 1989/90 fiscal year, M. Papst, Science, Central and Arctic Region, replaced G. Koshinsky, one of the original members of AFSAC on the Executive Committee. The chairpersons of the Subcommittee also serve on the Executive Committee so the changes in the chair of the Fish Subcommittee were also reflected in the Executive Committee.

AFSAC ACTIVITIES

During 1989/90 AFSAC reviewed background documents on two fish stocks, three fish species, two commercial fisheries, four marine mammal stocks, as well as reports on bowhead censusing methods and annual commercial anadromous Arctic charr fisheries. The Marine Mammal Subcommittee also discussed a framework for developing management and research recommendations. A list of the background documents prepared for AFSAC in 1989/90 is provided as Appendix 1. The AFSAC background reports on fish stocks were reviewed at the Winnipeg meeting of the Fish Subcommittee on March 14, 1990. The Marine Mammals Subcommittee met in Winnipeg on February 22, 1990. At those meetings, the Subcommittees completed their reviews of and developed their recommendations for management and needed research on the stocks and/or species.

In 1989/90 the Marine Mammals Subcommittee of AFSAC, at the request of the Director, Fisheries and Habitat Management, Quebec Region, carried out a review of the Ungava Bay beluga stock and provided that region's fisheries managers with advice. The Quebec Region includes the coastal waters of Eastern Hudson Bay, and southern Hudson Strait which abut the areas of jurisdiction for the Central and Arctic Region, (offshore waters in northern Hudson Strait and southern and western Hudson Bay) so there are Arctic stocks managed in these areas either by the Quebec Region, or jointly by both regions. AFSAC will continue to function as a body to provide management advice on these Quebec Arctic stocks as required.

In June, 1990, an urgent request was received from the Regional Director, Fisheries and Habitat Management for AFSAC's views on a number of questions related to an exploratory coregonid fishery in the Mackenzie Delta. A test fishery had taken place the previous year (1989) and AFSAC had provided advice about that fishery. In the application for renewal of the exploratory licence for 1990, and increased quota was sought, this required a second review by AFSAC. All available information was provided to the Fish Subcommittee and written responses to the questions raised by the Regional Director were provided by June 28. A summary of that response from the Fish Subcommittee is included in this report.

In 1990/91 AFSAC reviewed reports on four fish stocks, one fish species, two marine mammal stocks, commercial anadromous Arctic charr fisheries and provided a series of recommendations for future charr research in Arctic Canada. The Marine Mammal Subcommittee of AFSAC held its annual review meeting for 1990/91 on February 19-20 in Burlington where, for the first time, a joint meeting took place with the Marine Mammals Subcommittee of CAFSAC.

GENERAL RESULTS

The main results of AFSAC's activities in 1989/90 continued to be the development of management recommendations and the identification of research requirements for three fish stocks/stock complexes, and four marine mammal stocks. As well, 1990/91 quota recommendations were revised for anadromous Arctic charr commercial fisheries in the Northwest Terri-tories. AFSAC recommended that no hunt be allowed for one of the marine mammal stocks (Ungava Bay beluga) reviewed in 1989/90 and recommended that the hunt for another stock (eastern Hudson Bay beluga) be cut back substantially in order to prevent decimation of the stock.

In 1990/91, advice was provided on the management of one marine mammal stock, one marine mammal species, and four fish stocks. As well, a series of recommendations were made for the future direction of Arctic charr research in Arctic Canada.

The use of common reporting format by the Subcommittees was continued. The basic format is:

- Introduction
- Background
  - Stock definition
  - Stock size
  - Vital parameters
  - Current harvest
  - Other impacts
- Major issues
- Assessment
  - Stock prognosis
- Management recommendations
- Research requirements
- Next AFSAC review

In 1990/91 the Fish Subcommittee developed some guidelines for future report formats. These are included as Appendix 5.

The specific recommendations from each review are contained in the reports of the Fish Subcommittee for 1989/90 and 1990/91, and of the Marine Mammals Subcommittee for 1989/90 and 1990/91; these constitute the four major sections of this report. They include summaries of the information presented and AFSAC's advice on the stocks/species considered.

In this year's report, literature citations and references have been included. These will benefit those readers seeking more information on species being reviewed. In addition, glossaries of terms have been developed and are included as Appendix 3 for the Marine Mammals Subcommittee and Appendix 4 for the Fish Subcommittee. The definitions contained in these glossaries are those which have been accepted by the Subcommittees and apply to this annual report. Future annual reports by AFSAC will also contain these glossaries.

Figure 1 has also been added to this report. It contains a map marked with the locations referred to in the text and will be of benefit to those unfamiliar with some of the areas frequented by Arctic species.

GENERAL CONCLUSIONS

As part of its annual stock review meeting, the Marine Mammal Subcommittee discussed the contents of a background document titled "Framework for Making Management and Research Recommendations by the AFSAC Marine Mammals Subcommittee: Objectives, Data Requirements and Definition of Terms." As a result of these discussions, the Marine Mammals Subcommittee concluded that a more clearly defined framework was needed for making decisions and improving the efficiency of its review process. That framework is included in the report of the Marine Mammals Subcommittee for 1989/90. The Subcommittee also concluded that a number of specifically defined terms were required to provide a clearer understanding of subjects such as vital rates and recommended harvest levels for marine mammals. Some of these terms are new and significantly different from those used in fin fish management [e.g. total allowable removal (TAR) versus total allowable catch (TAC)]. The development and use of terms which differ from those used in earlier reports has prompted the development of a glossary which is included as an appendix to this report.

The Fish Subcommittee, during its review meeting in 1989/90, concluded that a formalization of report formats for documents prepared for and by AFSAC Subcommittees should take place. As well, the Subcommittee has decided to incorporate a glossary of terms used in its review of the various stocks and species. This was prompted, at least in part, by the reviews carried out on new species such as the Iceland scallop whose vital parameters are different from those in more standard fish species.

Overall, the Subcommittees of AFSAC continued to agree that biological data on Arctic species are still inadequate. Once again, it was pointed out that there is a continuing need to collect basic biological data on several Arctic species, particularly those in the marine environment not previously exploited for commercial or subsistence purposes. As well, there is a need for continuity in the collection of data, a need for collection of accurate and uniform catch statistics, as well as for continued research on stock identification through genetics and on recruitment. As long as resources for Arctic stock assessment research continue to be allocated on an uncertain year-to-year basis, the required research will be very slow and much important work will remain undone.

REPORT OF THE AFSAC MARINE MAMMAL SUBCOMMITTEE: 1989/90

INTRODUCTION

On February 22, 1990, the Marine Mammal Subcommittee met to review four marine mammal stocks, evaluate the Bering Sea bowhead census method and discuss a formal framework for developing management and research recommendations. In response to client concerns about the brevity of AFSAC stock sheets, the Subcommittee changed the stock sheet format slightly and broadened it to include a more detailed discussion of some of the topics, as well as literature citations and references.

The Ungava Bay and Eastern Hudson Bay beluga whale stocks were reviewed at the request of Quebec Region, in anticipation of the preparation of recovery plans for these stocks. These reviews will form the basis for recovery plans for the stocks under development by a DFO working group. The High Arctic beluga stock was reviewed for the first time. Ringed seals were reviewed again, in anticipation of results from aerial surveys of Cumberland Sound.

The Subcommittee reviewed the following background documents:
- Beaufort Sea beluga. T. Strong (AFSAC Document 89/90-01);
- Ungava Bay and Eastern Hudson Bay beluga. R. Reeves and E. Mitchell (AFSAC Document 89/90-03);
- Ringed seal. S. Innes (AFSAC Document 89/90-05);
- Lancaster Sound beluga whales. S. Cosens and R. Stewart (AFSAC Document 89/90-06); and
- Framework for making management and research recommendations by the AFSAC Marine Mammal Subcommittee: objectives, data requirements and definitions of terms. S. Cosens, S. Innes, P. Richard, R. Stewart and T. Strong (AFSAC Document 89/90-15).

In addition to the beluga stocks discussed at the February meeting, the Subcommittee reviewed the Beaufort Sea beluga stock during the summer of 1989, in response to a request by the Fisheries Joint Management Committee (FJMC). The stock sheet developed at that time for this stock is also included in this report.

During 1988/89 the Marine Mammals Subcommittee had reviewed the Bering Sea bowhead stock. At that time the Subcommittee used the population estimate derived from a visual/acoustic mark-recapture method and also used by the International Whaling Commission (IWC) to set its quotas. However, a recommendation was made by the Subcommittee in its 1988/89 report (Cosens et al. 1990) to review the census method because of concerns about biases in sampling procedure. The mark-recapture technique was reviewed in 1989/90 and conclusions are presented with this report at the end of the section on Canadian western Arctic bowhead whale.

In an effort to facilitate the development of recommendations and identify the most useful types of data, the Subcommittee discussed objectives of the AFSAC Marine Mammals Subcommittee and identified the decisions which are made during its review process. A framework was developed for making decisions to improve the efficiency of the review process and facilitate priorization of management and research recommendations. The Subcommittee also prepared a list of terms which are frequently used in AFSAC marine mammal stock sheets. Included in the glossary (Appendix 3) are definitions which the Subcommittee has agreed will apply to these terms. Authors of future background documents for AFSAC will receive this glossary for use in report preparation.

FRAMEWORK FOR MAKING MANAGEMENT AND RESEARCH RECOMMENDATIONS BY THE AFSAC MARINE MAMMALS SUBCOMMITTEE: OBJECTIVES, DATA REQUIREMENTS AND DEFINITIONS OF TERMS

Introduction

The Marine Mammals Subcommittee of AFSAC is charged with specific responsibilities as stated in the Terms of Reference and Operating Procedures, April, 1987. In carrying out these responsibilities for assessing the status of marine mammal stocks and making biologically sound recommendations to fisheries managers, the Subcommittee reviews background documents on specific stocks or topics. Documents are prepared for AFSAC by designated authors at the request of the Director, Biological Sciences and/or the Regional Director of Fisheries and Habitat Management. In the background documents, authors summarize current information from published literature, unpublished data and other sources relating to the status of marine mammal stocks. The Marine Mammals Subcommittee reviews and discusses these background documents and prepares stock status sheets based on its deliberations. These stock status sheets, in addition to summarizing vital information on population size, parameters and trends, also contain recommendations for management, further research and the timing of the next review by AFSAC.

The Subcommittee does not have an active management role in that it is not responsible for implementing management or research recommendations contained in its reports. It does, however, make recommendations which are meant to be used by fisheries managers as part of the decision-making process. Development of these management and research recommendations by the Subcommittee demands that decisions be made about stock status and the type of management actions that best meet management goals of conservation and protection of the natural resources. Harris and Kochel (1981) suggest that having a formal decision-making framework clarifies objectives and ensures that the management actions selected are appropriate for achieving those objectives. The Subcommittee also needs to ensure that the research recommendations are the ones which best address gaps in existing information. To develop a formal framework for making recommendations, the Marine Mammals Subcommittee members reviewed their responsibilities and information needs. This report outlines the results of these discussions and presents the framework that will be used by the Subcommittee to assess stocks and develop recommendations about management actions and research requirements.

The Subcommittee also developed a glossary of terms which will be made available to future authors of background reports for AFSAC. At its meeting the previous year (Cosens et al. 1990), the Subcommittee identified the need to define the terminology being used in its reports. The meaning of ecological terms was often unclear, even in the published literature where various authors often assign different meanings to the same term. The Subcommittee was able to identify and define the terms that would be included in its reports on a regular basis. The glossary, included as Appendix 3 will permit authors of background documents and readers of AFSAC reports to understand and use this terminology in a consistent manner.

Objectives

According to Harris and Kochel (1981), management science involves making rational decisions following a simple set of procedures. They pose five questions that may be used to define decision points and identify the options to be selected at each decision point. With some minor changes, the Subcommittee used these questions to develop its decision-making framework. They are:

1) What are the desired states of nature?
2) What are the relevant states of nature at present?
3) What are the alternative courses of action?
4) What are the consequences of each alternative?
5) What information is available to relate the magnitude of each action to the likely consequence? Defining the decision points used by the Marine Mammal Subcommittee is relatively straightforward and four major objectives can be outlined.

Objective 1: The desired state of the marine mammal stock should be defined. This decision is not made by AFSAC but by managers (Fig. 2) responsible for implementing management policy. Requests from managers to AFSAC for advice or a stock review should include information on their long-term goals for the stock. For some marine mammal stocks the management goals have not been adequately described and, as a result, the Subcommittee must assume that the goal is to permit no decline in stock size for most marine mammal stocks. For those stocks which are considered endangered, the assumed goal is one of increasing stock size.

Objective 2: The second major objective of the AFSAC process is to define the current state (i.e. status) of Arctic marine mammal stocks. Meeting this objective requires review of available information which is compiled in background documents and submitted to the Subcommittee. The Subcommittee must evaluate this information for scientific merit and accuracy, select the best data and make a decision about current stock status. Often, there is too little information available to permit a reliable evaluation of stock status. The information gaps must then be identified as research needs (Fig. 2). If stock status can be determined within measurable limits, the Subcommittee is ready to move on to the next state in the process.

Objective 3: If the current stock status is different from the desired stock status, recommending a course of action to achieve the desired stock status is the third objective of the Subcommittee (Fig. 2). The method typically used to maintain or change the status of the stock is adjustment of the total allowable removal (TAR) during the harvest. Adjustments of the timing and sex or age bias of the harvest are also possible actions. In the past, the Subcommittee has typically selected a single value for TAR, the one thought to best achieve the desired management objective. However, the Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC), in its assessments, offers several possible courses of action ranging from low to high risk levels of harvest. The Marine Mammal Subcommittee process has incorporated this approach and will make recommendations which include a range of total allowable removal levels for each stock. Each alternative is then accompanied by an outline of the likely consequences of choosing a low, medium or high risk level of removal.

Objective 4: Finally, the Subcommittee must indicate what information is needed to assess the outcome of its recommended management actions. This objective will be reflected in recommendations for monitoring. Recommendations for monitoring are presently fairly general and often do not specifically address the problem of assessing the impact of the management actions.

Data requirements

Objective 1: Resource managers must define the desired stock status. This may involve evaluating the 'best use' of a stock through discussions with various users of marine mammal populations. Thus some agreement will have to be reached among different users as to the level at which stocks should be maintained. Should conflict then arise between different resource users, such as commercial versus subsistence hunters, then resource managers will have guidelines as to what actions need to be taken.

Objective 2: One of the most difficult objectives for AFSAC to meet is that of defining current stock status. Both the geographic range and size of the stock need to be delineated. This is especially important for those stocks that overlap spatially but which may not interbreed. Information on migration rates is also required to evaluate the vulnerability of stocks to depletion and to inbreeding depression at small stock sizes. Finally, it must be determined whether the stock size is stable or changing (i.e. increasing or decreasing). Appropriate management actions to achieve desired stock status cannot be recommended without knowing whether the stock size is at the desired level or not. Research recommendations typically address shortfalls in this information base.

Objective 3: The primary management action recommended by AFSAC is that of adjusting the Total Allowable Removal (TAR) to a level thought to be appropriate for accomplishing management goals. AFSAC presently uses the estimated maximum finite rate of increase (see Reilly and Barlow 1986) as a basis for setting removal levels on a stock-by-stock basis. This parameter can be derived by observing the sensitivity of population growth models to variables such as calf mortality, adult mortality, calving interval and age of first reproduction. For some species, models provide the best estimates of population growth because mortality rates in real populations are impossible to measure accurately. In other species, enough individuals can be sampled to estimate age specific fecundity and survivorship. Gaps in information on population growth rates are addressed in the research recommendations.

Objective 4: Gathering information to evaluate the impact of a management action on the stock involves monitoring such as through the collection of harvest statistics. The Subcommittee must first predict the effects that the management action will have on the stock. Secondly, it must identify the variables that should be measured. Thus, the actual response of the stock can be compared to the expected or desired response.

As part of this need to monitor the effects of a management action on a stock, the Subcommittee should be prepared to conduct risk analyses to estimate how much a stock parameter must change before the change can be detected. This approach becomes vital when data must be collected within a limited timeframe and budget and a method must be chosen accordingly.

Definition of terms

There are a number of terms which are frequently used by the Marine Mammals Subcommittee, particularly when preparing its reports. Some of the terms are new, having been introduced as a result of discussions about the decision making framework. The associated definitions have been agreed upon by the members of the Subcommittee and are included with this report as Appendix 3. Authors of future background papers for the Marine Mammals Subcommittee of AFSAC are encouraged to use these terms where applicable. Also, authors may, from time to time, introduce terms not included in the glossary. These terms should be clearly defined and referenced and will be added to the list.

Summary

This report sets out a framework for the process that the Marine Mammals Subcommittee uses to provide advice to managers. Having obtained a clear statement of the management objectives, the Subcommittee reviews invited background documents, assesses the stock relative to the management goal, recommends management approaches to attain that goal and provides a risk of failure assessment of each option. It suggests areas where research is required to improve its management recommendations. A glossary of biological definitions is provided to assist authors to prepare background documents and allow the Subcommittee, managers and clients to discuss issues in a common language. The framework for the process by which the Marine Mammals Subcommittee of AFSAC carries out its responsibilities for providing biologically sound advice has been outlined. This process relies upon clear statements of management objectives for stocks or issues referred to AFSAC for review and adequate up-to-date biological information for the assessment process. The process also requires feedback on the outcome of management actions taken on the stock(s) or issues and on the relationship between management actions and the recommendations of the Subcommittee. With these inputs the overall process will continue to evolve and improve as it has done since AFSAC was established in 1986.

BEAUFORT SEA BELUGA

Introduction

This stock was reviewed at the request of the Fisheries Joint Management Committee (FJMC) which was involved in developing a belugas management plan for the Canadian waters of the Beaufort Sea. The review was also an opportunity to examine the results of a recent DFO aerial photographic survey of belugas in the Mackenzie Delta.

Background

Stock definition: In the Canadian Beaufort Sea, belugas range in summer from the continental landmass north to the limit of the pack ice and from the U.S. boundary east through the Amundsen Gulf. (Fig. 1). By mid-August, belugas are moving westward, probably to the Bering and Chukchi Seas where they are thought to overwinter. In spring, they migrate eastward along the Alaskan coast to the vicinity of Point Barrow and then follow offshore leads to their summering areas. These whales are thought to be part of a population that includes animals from the Bering, Beaufort, Chukchi and eastern Siberian Seas and the Amundsen Gulf (Seaman et al. 1985), and are referred to as the Beaufort Sea or Beaufort stock (Finley et al. 1987). The Beaufort Sea belugas are geographically isolated from those summering in Alaskan waters along the south shore (i.e. Bristol Bay) and also from those summering in the Canadian high arctic in the waters off Lancaster Sound.

Stock size: Data collected by Norton and Harwood (1985) and DFO in 1986, indicate that the Canadian Beaufort Sea from 140°W to 128°W and 71°N to the Mackenzie River Delta contains a mean of about 7 000 (with a 95% confidence interval of 3 335 to 10 827 beluga). This estimate is uncorrected for submerged animals. There are also beluga whales outside of this area, for example, north of 71°N and in Amundsen Gulf, but they have not been adequately censused.

Vital parameters: Age of first ovulation, calving interval and birth rate are based on samples from Alaskan belugas (Burns and Seaman 1985).

Age of first ovulation: 4-7 years
Mean calving interval: 3 years
Annual birth rate: 10% of total population
Finite rate of increase: 2-3% of total population per annum (Beland et al. 1988; Doidge, (Makivik Corp. Kuujjuaq, Quebec); Reilly and Barlow 1986)

Current harvest: The landed harvest in the Canadian Beaufort Sea from 1981-1986 averaged 123 belugas annually and the mean annual loss rate was 18% (Strong 1990). Total removal is estimated at 123 x 1.22 = 150 belugas per year. This estimate is based on the assumption that all animals struck and lost are removed from the population (i.e. they die within a short period of time). Strong 1990 argue that total removal may be 25% higher (164) than reported landings when other factors including struck and lost whales, abandoned neonates and pregnant females are all considered.

Given an estimated finite rate of increase of 2.5%, total allowable removal (TAR) is calculated at 177 whales (7 081 x 0.025), including struck and lost whales. The current Canadian harvest (not restricted) does not exceed this value even when lost, abandoned neonates and pregnant females are factored in.

Other impacts: Beaufort Sea belugas are also likely being harvested during spring migration along the northwest and north coasts of Alaska where the average annual removal is about 120 (Lowrey et al. 1989). This estimate includes losses which range from 20-60%. However the actual relationship between these migrants and the belugas summering in the Canadian Beaufort Sea is unclear.

The hydrocarbon industry is well developed in the Beaufort Sea and future exploitation of both oil and gas reserves is simply a matter of economics. Expanded exploration for and the production of hydrocarbons has the potential to be a limiting factor for belugas in the area.

Hydroelectric development has been proposed within the Mackenzie River drainage. Such activity will affect the water regime and, therefore, has the potential to be a limiting factor for belugas because they frequent estuaries, especially the freshwater areas during the summer, possibly to moult and feed.

The development of a deep water port within the Inuvialuit land claim area is an ongoing issue and port facilities currently in use will require upgrading. Port development or upgrading and the attendant increase in ship traffic may impinge upon the well-being of the beluga stock and have the potential to be a limiting factor.

The exploitation of various species of marine fish is being contemplated within the Beaufort Sea. Such activity may have a detrimental effect on the belugas food chain and, therefore, has the potential to be a limiting factor.

Major issues

Proposed increased harvest: The Inuvialuit would like to increase their harvest of belugas. The Canadian harvest alone does not exceed the moderate risk TAR (see management recommendation #1), but with the Alaskan hunt included, total removal (150 + 120 = 270) is at the high risk level. There is no TAR applied to the Alaskan hunt.

Assessment

Stock prognosis: There is no indication at the present time that the stock is declining.

Management recommendations

1. Harvest levels should not be increased until better data are available on stock size or vital rates. Based on current estimates of stock size, a low risk TAR is calculated to be 3 335 whales x .025 = 83 whales. A moderate risk TAR is calculated to be 7 081 x .025 = 177 whales. A high risk TAR is estimated to be 10 827 x .025 = 270. A high risk TAR is considered to have a high probability of causing a decline in stock size.

2. Hunt monitoring should be continued to improve statistics on numbers of whales struck and landed.

3. Managers may wish to consider using a two-tiered system of struck and landed whales when defining harvesting strategy harvest. This approach specifies a certain number of whales which can be struck and another number (less) which can be landed. The harvest stops when either number is reached, thus, if the number for belugas struck is reached the hunting stops even though no whales might have been landed. This is an approach used by the IWC to discourage poor hunting practices. Such a system encourages a reduction in the number of whales struck but lost during the hunt.

Research requirements

1. A major aerial census of Beaufort Sea beluga stock, including the inshore and offshore Beaufort Sea and the Amundsen Gulf should be carried out. Data from such a survey are required to derive a more comprehensive estimate of stock size than is presently available.

2. Work on vital rates should be continued. This includes completing and publishing the study by Doidge (Makivik, Corp., Kuujjuaq, Quebec) and continued collection of stock specific data on vital rates in order to provide estimates of stock specific finite rates of increase.

3. Tagging studies need to be continued to track movements of whales. These both complement aerial survey data and permit evaluation of the time spent by whales in inshore and offshore waters. This information will facilitate assessment of the ability of this stock to support both an Alaskan and Canadian harvest.

Next AFSAC review

The next review should be held upon completion of a major aerial survey, vital rates study or tagging study as described above.

HIGH ARCTIC BELUGA

Introduction

This review represents the first for this stock by AFSAC. In 1987, AFSAC reviewed beluga populations in, what was referred to as, sub Arctic areas of the Northwest Territories.

Background

Stock definition: This stock summers in waters around Lancaster Sound. Aerial surveys have located large summer concentrations in Creswell (Smith et al. 1985), Garnier, Elwin and Batty Bays (Smith pers. comm.) on Somerset Island. (Fig. 1). Although some belugas may overwinter in loose pack ice in Lancaster Sound (Sergeant and Brodie 1975), most are thought to winter south of Disco Island along the west coast of Greenland, where large numbers of beluga whales have been sighted during aerial surveys in March (McLaren and Davis 1981, 1983). Lancaster Sound is a spring and fall migration route for these whales.

Whether belugas that summer in the Canadian high arctic are the same ones that overwinter along the coast of Greenland is not definitely known. The catch chronology of harvests around Disco Bay, where most of the hunting takes place in February and March, provides circumstantial evidence that high arctic belugas are being hunted in Davis Strait during winter. Morphometric data suggest otherwise but are equivocal. Belugas caught off the west coast of Greenland were found to be larger than those caught in Lancaster Sound (Sergeant and Brodie 1969) but this comparison was based on Greenland samples collected 40 years earlier than the Lancaster Sound samples. If changes in population age structure occurred between 1926 and 1966, then comparison of these data sets to test for stock separation is inappropriate. If the west Greenland and high arctic belugas are from two discrete stocks, then the wintering area of the high arctic belugas is unknown.

The western end of the range appears to extend to Prince of Wales Island (Sergeant and Brodie 1975). Mixing with the Beaufort Sea beluga stock is probably limited because the Beaufort Sea belugas range only as far east as Banks Island (Sergeant and Brodie 1975), so the two stocks are separated by Viscount Melville Sound.

Stock size: Stock size was most recently estimated by Smith et al. (1985) who used a stratified visual aerial survey of Lancaster Sound, Barrow Strait and Prince Regent Inlet in July and August, 1981. From transect coverage, they calculated a 95% confidence interval of 4 200 to 16 500 whales with a mean of 8 300 whales. The addition of about 2 100 whales seen in estuarine aggregations results in an estimated range of 6 300 to 18 600 individuals or a mean population size of 10 400 whales.

This population estimate is uncorrected for submerged animals and does not include Peel Sound, Admiralty Inlet, Navy Board Inlet or any of the channels north of Lancaster Sound. Aerial surveys of Admiralty Inlet and Navy Board Inlet in July and August, 1975 by Fallis et al. (1983) sighted few belugas, so these areas are not thought to be important summering locations. Sightings of beluga aggregations and tracking of a radio-tagged belugas suggest, however, that Peel Sound may be an important summer feeding area. Results of the aerial surveys conducted by Smith et al. (1985) are consistent with an earlier estimate of about 10 000 whales (Sergeant and Brodie 1975), however, the previous estimate did not quantify survey precision so is not directly comparable to that made by Smith et al. (1985). If these whales are also being harvested in Davis Strait, then harvest data suggest that the stock size must exceed 18 600 whales. Harvest rates have been too high to be sustained by a stock size of even 18 600 whales.

Vital parameters: There are no published estimates of vital rates for this stock. All available information is based on samples taken from other populations.

Mean age of first ovulation: 5 years (Brodie 1971; Sergeant 1973)
Mean calving interval: 3 years (Brodie 1971)
Annual birth rate: 7% of total population (Richard and Orr 1986)
Finite rate of increase: 2-3% of total population per annum (Beland et al. 1988; Reilly and Barlow 1986)

Current harvest: In Canada, the total landed harvest averages 89 whales per year by the following communities: Broughton Island, Clyde River, Pond Inlet, Arctic Bay, Grise Fiord, Resolute, Creswell Bay (Strong 1989). The largest numbers are taken in Grise Fiord (22) and Creswell Bay (34). Loss rates are unknown. There are currently no restrictions on the harvest of this stock in Canada.

In Greenland, harvests are significant, with up to 1 000 animals being landed annually (Kapel 1981). Catches are largest around Disco Island in winter or late spring, averaging about 450 whales (Kapel 1977). Few whales are taken in summer. In late fall, from October to November, catches are high along the northwest coast of Greenland, averaging about 260 whales annually (Kapel 1977). More recent data indicate that in 1983 and 1984, harvests (including losses) continued to be high, totalling 446 and 700 whales respectively. In 1989, an estimated 700 whales (including losses of about 30%) were killed by only two communities (Upernavik and Ummannaq). An additional 600 animals were taken in a savassat (Heide-Jorgensen, Greenland Fisheries Institute, pers. comm.). The proportion of high arctic belugas in this harvest is not known, but it could be significant.

Given an estimated finite rate of increase of 2.5%, a population of 10 400 belugas could support a removal of 260 whales. A population of 18 600 whales, the maximum estimated stock size, could support a removal of 465 whales. If belugas harvested off the coast of Greenland are of the high arctic stock, at least 800 whales (709 from Greenland and 89 plus from Canada) are being removed annually. A stock size of even 18 600 would be extirpated fairly quickly at a harvest rate of 800 animals per year. However, this stock has sustained a high level of harvest for many years (Kapel 1977), thus it seems likely that stock size must exceed 18 600.

Sustainable removal of 800 whales per year requires a stock size of about 32 000 whales. Although the Canadian harvest is much below the estimated safe level of removal, the Greenland harvest may be in excess of what the stock can support over the long term.

Other impacts: Development, such as exploration for hydrocarbons in the wintering areas off the coast of Greenland, could have a significant impact on this stock of beluga whales by causing habitat alterations.

Commercial shrimp fisheries could also have an impact on this stock by removing food resources used by wintering whales.

This stock of beluga whales has shown sensitivity to underwater noise generated by ice-breaking vessels in Lancaster Sound (Cosens and Dueck 1988; Finley et al. 1984), with belugas moving away from ships up to 50 km away. The degree of geographic and seasonal variation in levels of response to disturbance has not been studied.

Major issues

Possible overharvesting: If high Arctic beluga whales overwinter along the west coast of Greenland, they are probably being overharvested. The harvest of belugas by Greenland does not appear to be sustainable, given current estimates of numbers for the high Arctic beluga stock.

Habitat alteration: If commercial fisheries and other activities in the wintering areas are reducing food resources or degrading habitat quality, these factors will have a negative effect on the size of this stock.

Assessment

Stock prognosis: Given the current estimates of stock size and harvest levels, there is concern that the stock is declining.

Management recommendations

1. Managers should contact Greenland authorities to identify the management problems and develop a joint management program. According to the current estimated stock size, total allowable removal (TAR) should be limited to a maximum of 465 whales (18 600 whales x .025) which is considered to be the high risk level of removal. A moderate risk TAR is recommended to be 10 400 x .025 = 260 whales. A low risk level of removal is recommended to be 6 300 x .025 = 158 whales.

2. Managers should obtain more recent information from Greenland on harvest levels including numbers struck and lost. This information should indicate where and when belugas are being taken. Additional Greenland harvest data are needed to determine whether current removals exceed those in the period 1965 to 1975, and whether there is any attempt to limit harvests in that country.

Research requirements

1. Information on the age of harvested animals should be collected to determine whether the stock is being overharvested. Assuming that animals are selected for size, the age of the oldest landed animals will indicate whether the old animals have been removed from the population.

2. Tagging, morphometric or genetic studies should be done to delimit the stock. Perhaps testing for some other marker such as heavy metals might also be done to identify stock affinities. This information is necessary to assess whether the whales being taken by Greenland are of the high arctic stock.

3. Film from 1985/86 aerial surveys of Peel Sound and Prince Regent Inlet should be analyzed to determine if significant numbers of beluga whales are using these areas during the summer. This information will facilitate estimation of stock size by indicating whether these areas are heavily used.

4. Using aerial photographic techniques, the age distribution of summering animals should be monitored. Age structure can be used to assess whether the stock is declining or not.

Next AFSAC review

The next review should be carried out when new Greenland harvest statistics are available or when research results become available.

UNGAVA BAY BELUGA

Introduction

This stock, recently listed as endangered by COSEWIC, was reviewed at the request of Quebec region of the Department of Fisheries and Oceans. That region intends to develop a recovery plan for this stock and this review by AFSAC will provide a basis for the plan.

Background

Stock definition: The present summer range of this stock extends from Quaqtaq (Koartac) to Killiniq (Port Burwell). Historically, whales used estuaries of the Kangirsualijjuap Kuunga (George), Ungunniavik (Whale), Marralik (Mucalic), Kuujjuak (Koksoak) and Kuugaaluk (Leaf) Rivers (Reeves and Mitchell 1987a), but as recently as 1981, whales have been sighted primarily in the Mucalic River (Finley et al. 1982). Whales are present in Ungava Bay between late March and November (Finley et al. 1982).

Movement out of Ungava Bay begins in November. Current (Finley et al. 1982) and historical (Reeves and Mitchell 1987a) sighting records indicate that whales probably winter offshore in Hudson Strait.

The relationship between this and other stocks wintering in Hudson Strait is not clear. Interbreeding between stocks on the wintering grounds may occur. For management purposes, summering groups are recognized as the stock unit because local declines in estuaries traditionally used by belugas have been documented for this and other beluga stocks (Reeves and Mitchell 1989).

There have been no direct comparisons of morphometry between Ungava Bay belugas and other stocks wintering in Hudson Strait. However, measurements of Northern Hudson Bay whales, including those killed at Ungava Bay, Eastern Hudson Bay and Quaqtaq, are more similar to one another than they are to belugas of other stocks, such as Cumberland Sound (Finley et al. 1982). Affinity between Eastern Hudson Bay and Ungava Bay whales is suggested by these data.

Stock size: The most recent survey (Smith and Hammill 1986) could not produce a population estimate for this stock because only two whales were seen off transect. During a previous survey by Finley et al. (1982), less than 50 belugas were sighted, half of which were seen in the vicinity of the Mucalic River.

Vital parameters: There are no published estimates of vital rates for this stock. Given the small stock size, there will be no data collected in the foreseeable future. Estimates from other stocks are:

Mean age of first ovulation: 5 years (Brodie 1971; Sergeant 1973)
Mean calving interval: 3 years (Brodie 1971)
Annual birth rate: 7% of total population (Richard and Orr 1986)
Finite rate of increase: 2-3% of total population per annum (Beland et al. 1988; Reilly and Barlow 1986)

Current harvest: Harvests since 1978 have averaged about 50 whales per year, down from 158 whales per year during the period 1973 through 1977. A voluntary quota, set in 1987, permitted the landing of 25 whales in Ungava Bay, and an additional 101 whales from Hudson Strait where mixed stocks are likely to occur. In 1989, 22 belugas were taken from Ungava Bay (Olpinski 1990). Although the Ungava Bay harvest was within the quota, 267 belugas were harvested from Hudson Strait. The proportion of Ungava Bay whales taken in the harvest of mixed stocks in Hudson Strait is unknown.

Other impacts: Commercial fisheries for shrimp in Hudson Strait is a potential problem. Information on distribution and feeding behaviour of wintering whales is needed to assess how much of an impact fisheries might have on resources used by wintering beluga whales.

Increasing harp seal populations may also have an impact on these belugas if both species are using the same food resources. Although harp seals use Hudson Strait during the summer, they could deplete resources available for belugas during the winter.

Major issues

Overharvesting: In spite of concurrence by communities with harvesting restrictions in Ungava Bay, relatively large numbers of whales continue to be taken in Hudson Strait. Even the current harvest in Ungava Bay is higher than the number of whales sighted in the last survey. Overharvesting has depleted this stock and is reducing its chances of recovering.

Assessment

Stock prognosis: This stock has been severely depleted, apparently as a result of overharvesting by both commercial and subsistence hunters (Reeves and Mitchell 1987a). It is listed as endangered by COSEWIC. Without closure of the harvest, stock eradication is likely.

Management recommendations

1. Closure of the hunt of beluga whales in Ungava Bay should be implemented.
2. Resources to enforce the closure of the hunt should be provided.
3. The effects of hunt closure should be monitored by recording sightings and other information where possible.

Research requirements

The stock is too small to warrant development of research plans. In the event that there is evidence of stock recovery, a plan should be developed.

Next AFSAC review

The next review should be done after closure of the hunt or when new information becomes available.

EASTERN HUDSON BAY BELUGA

Introduction

This stock, listed as threatened by COSEWIC, was reviewed at the request of Quebec region of DFO. The region intends to develop a recovery plan for this stock and the review by AFSAC will provide a basis for the plan.

Background

Stock definition: This stock has usually been called the Eastmain stock (Reeves and Mitchell 1989), however, eastern Hudson Bay more appropriately defines its summering range which extends from James Bay north to the Nastapoka

River and west at least as far as the Belcher Islands. (Fig. 1). The southern and western limits of the range are somewhat arbitrarily defined. The relationship between whales of James Bay and those of eastern Hudson Bay is not known. Surveys indicate a continuous summer distribution of belugas from western Hudson Bay through James Bay to eastern Hudson Bay (Richard unpublished data; Smith and Hammill 1986). Reeves and Mitchell (1987b) suggest that, although James Bay and eastern Hudson Bay whales may be one biological stock, they should be treated as separate stocks for management purposes. A conservative management approach is to consider belugas from eastern Hudson Bay and James Bay to be of different stocks until new information indicates otherwise.

The Nastapoka and Little Whale Rivers are the primary summering areas of the eastern Hudson Bay stock. Historically, large concentrations were also found in the Great Whale River, but this estuary is no longer used (Reeves and Mitchell 1987b; Smith and Hammill 1986). Whales begin to arrive at the summering areas in late June and leave in September (Reeves and Mitchell 1987b), presumably wintering in Hudson Strait (Finley et al. 1982).

Stock size: The most recent survey (Smith and Hammill 1986) estimated a mean stock size of 1 442 (95% Confidence Interval = 1 124 to 1 904) not including submerged animals. This survey was stratified, sampling both inshore and offshore habitats. Coverage did not include areas north of the Nastapoka River because local hunters indicated that whales were not seen in this area during the summer. This estimate is larger than the one previously obtained by Finley et al. (1982), which indicated fewer than 350 whales. However, the 1986 survey included offshore areas such as the Belcher Islands which had not previously been surveyed.

Vital parameters: There are no published data on vital parameters of this stock, although there is a study in progress (Doidge, Makivik Corp., Kuujjuaq, Quebec). Estimates from other stocks are as follows:

Mean age of first ovulation: 5 years (Brodie 1971; Sergeant 1973)
Mean calving interval: 3 years (Brodie 1971)
Annual birth rate: 7% of total population (Richard and Orr 1986)
Finite rate of increase: 2-3% of total population per annum (Beland et al. 1988; Reilly and Barlow 1986)

Current harvest: Harvest data indicates an average of 117 whales were landed each year between 1978 and 1985. In 1986, 58 whales were landed. In 1987, a voluntary quota of 60 landed whales from eastern Hudson Bay and 60 landed whales from Hudson Strait was set for eastern Hudson Bay communities. In 1989, 79 whales were harvested in eastern Hudson Bay and 267 whales were harvested in Hudson Strait (Olpinski 1990). The proportion of eastern Hudson Bay whales taken in the Hudson Strait harvest is unknown. Current harvest in eastern Hudson Bay represents about 5% of the mean estimated stock size.

Other impacts: As with other stocks wintering in Hudson Strait, commercial fisheries for shrimp could deplete food resources used by these whales.

The province of Quebec has plans to develop major hydroelectric projects on the Nastapoka, Little Whale and Great Whale Rivers. Changes in the flow rates, ice patterns and mercury levels could affect belugas that use the Little Whale and Nastapoka estuaries in summer.

A new settlement has been established at Umiujak, relocating hunters from Kuujjuarapik (on the Great Whale River) closer to the Nastapoka River where there is access to beluga whales. This new settlement could increase hunting pressure on this stock.

Major issues

Potential overharvesting: Given the current estimated stock size, the present level of harvest may not be sustainable over the long term. The most recent population estimate did not include a factor to account for submerged whales not counted in the aerial census. As well, the relationship between whales in James Bay and eastern Hudson Bay is not known. Thus the stock size estimate may be low.

Habitat modifications: Habitat modifications caused by hydroelectric projects in the summering areas and commercial fisheries in the wintering areas of this stock may have detrimental effects on stock survival.

Assessment

Stock prognosis: Given the uncertainty about estimates of stock size, this stock might be stable but additional information is needed. New hydroelectric projects scheduled for the Little Whale and Nastapoka Rivers, the last remaining estuarine concentration areas, could seriously endanger the stock if such developments produce any detrimental effects on belugas habitat.

Management recommendations

1. Given the current estimated stock size, total allowable removal (TAR), including whales struck and lost should not exceed a maximum of 48 whales. A low risk level of removal, calculated by multiplying the minimum estimated population size (1 124) by the average finite rate of increase (2.5%), is 28 whales. A moderate risk level of removal is 1 442 x .025 = 36 whales, and a high risk level of removal is 1 904 x .025 = 48 whales. The low risk TAR is believed to have a low probability of causing a decline in stock size. Alternatively, a high risk TAR is considered more likely to cause a decline in stock size. Removal of fewer than 28 whales will likely permit the stock to increase in number.

2. Hunters should be encouraged to avoid striking females with calves to maintain the reproductive capacity of the remaining stock.

3. Struck and loss rates should be estimated at both inshore and offshore locations such as the Belcher Islands. Harvesting conditions could differ from areas adjacent to the mainland and loss rates may differ accordingly. Total allowable removal includes lost animals, thus good estimates of loss rates are needed to ensure that the TAR is not being exceeded.

4. An infrastructure needs to be established to obtain better harvest statistics, including age and morphometric data, from the hunt of this stock.

Research requirements

1. A satellite tagging project should be developed to provide information on the location of wintering areas and the relationship between eastern Hudson Bay and James Bay whales. Tagging will also provide information on feeding behaviour and could be used to address concerns about impacts of fisheries on winter food resources.

2. Analysis of nuclear DNA from biopsy studies would enhance the understanding of the mating system, and permit an estimation of the amount of genetic interchange that occurs between stocks in the wintering areas. This type of information is of value in developing recovery plans for depleted stocks and in estimating minimum viable population size.

3. The southern part of the summering range, outside of the Nastapoka and Little Whale Rivers should be evaluated ecologically and its relative importance to the belugas assessed. This information is needed to determine how habitat degradation will affect the future status of this stock.

4. Areas of aggregation in James Bay should be sought to identify potential study sites for work on the relationship between this and other Hudson Bay beluga stocks.

Next AFSAC review

This stock should be reviewed again in 1990/91.

WESTERN ARCTIC BOWHEAD WHALES

Introduction

In 1989, AFSAC reviewed the stock status of the Bering Sea bowhead whales and, at that time, recommended that DFO evaluate the mark-recapture technique used to estimate the size of this stock. This census technique developed in Alaska to count the Bering Sea bowhead stock uses visual sightings as the initial marks and acoustically-derived whale tracks as the recaptures. Tracks are derived by recording and localizing vocalizations with a hydrophone array. A computer algorithm incorporating estimates of swimming speed and direction links locations of vocalizations as whale tracks. Visually "marked" whales that are matched with acoustic tracks are counted as marked and recaptured whales. Using a standard mark-recapture method, a population estimate is calculated. There are several possible sources of error in applying this type of mark-recapture method to bowheads. Accurate calculation of total allowable removals (TAR) requires a good estimate of stock size. Given the uncertainty about the effect of these biases on the final estimate of stock size, AFSAC (Cosens et al. 1990) recommended that the sources of bias be identified and the census technique be evaluated. The following parameters have been taken from the 1988/89 AFSAC Annual Report with revisions noted.

Background

Stock definition: This stock is distributed in the Beaufort, Chukchi and Bering Seas as far west as Mys Billingsa and as far east as Amundsen Gulf. The permanent polar pack ice limits northern movements. The southern limit in the Bering Sea occurs in the vicinity of St. Lawrence and St. Matthew Islands. This population is also known as the Bering/Chukchi/Beaufort Sea stock. The southeastern Beaufort Sea is a major summering area for this stock.

Stock size (revised): The previous estimate of 7 800, based on the combined visual and acoustical mark-recapture method, may be an overestimate. As a result of the review of this method, the AFSAC Marine Mammals Subcommittee has decided to use the estimate for the population of 4 417 (95% Confidence Interval = 2 613 to 6 221 whales). This estimate is based solely on visual sittings and is considered to be an underestimate. Use of this number is provisional until improved census data are collected.

Vital parameters: Unless otherwise indicated, the following parameters are taken from those estimated for the Bering Sea stock by Mitchell and Reeves (1986).

Female sexual maturity:	Age is unknown; but length of the animals is 13-14 meters
Mean calving interval:	3-6 years
Annual birth rate:	3.6-11.6% of total population
Finite rate of increase:	1% of total population per annum (I.W.C. 1989a &b)
Natural mortality rate:	unknown

Current harvest: No Canadian harvest occurs but the Alaskan Inupiat obtain a quota from the International Whaling Commission. In 1988, the I.W.C. approved a quota of 44 whales struck or 41 whales landed annually for the period 1988-1990 (I.W.C. 1989a).

Other impacts: Hydrocarbon development along the Alaskan North Slope and in the Mackenzie Delta may interfere with the migration and feeding patterns because of the disturbance effects of underwater noise generated by vessel and drilling activity.

Sources of natural mortality, including disease, predation, and ice entrapment are not well documented. Effects of environmental contaminants are also unknown. The distribution of summering whales appears to be correlated with the distribution of dense aggregations of copepods, thus any factor limiting the abundance of plankton could adversely affect bowhead whales.

Major issues

Endangered stock: This stock was depleted by commercial whaling. Current population trends are not known because census techniques have not been adequately standardized.

Hunting: The community of Aklavik has submitted a proposal to harvest a bowhead in the summer of 1989.

Assessment (revised)

Stock prognosis: The existing data on population size is not sufficient to permit an evaluation of population trends. The 1984 estimate was 3 871 (+254) whales, while the 1988 estimate (used in this report) is 4 417 (±1 804) whales.

Management recommendations (revised)

1. Based on this estimated stock size and a 1% finite rate of increase (I.W.C. 1989a, b) total allowable removal (TAR) is recommended to be: Low Risk: 26 whales, Moderate Risk: 44 whales, High Risk: 62 whales. The IWC currently permits 44 strikes or 41 landed whales to be taken from this stock, a level of removal which is within the moderate risk range.

REVIEW OF THE ESTIMATED STOCK SIZE FOR THE WESTERN ARCTIC BOWHEAD WHALE (*Balaena mysticetus*) AS GIVEN IN THE REPORT OF THE ARCTIC FISHERIES SCIENTIFIC ADVISORY COMMITTEE FOR 1988/89 (COSENS ET AL. 1990)

Introduction

The stock size estimate of 7 800 (95% C.I. 5 700-10 600) for the western Arctic bowhead whales (*Balaena mysticetus*), given in the Report of the Arctic Fisheries Scientific Advisory Committee for 1988/89 (Cosens et al. 1990), represents the conclusion of the International Whaling Commission (Anonymous 1989). The International Whaling Commission's Scientific Committee accepted a weighted mean of two estimates based on the single mark release (also known as the capture-recapture) model (see Seber 1982) using acoustic and visual cues from bowhead whales as they passed Point Barrow, Alaska, U.S.A. In this review, the assumptions implicit in the mark release method for the estimation of abundance, how well the observations of bowhead whales satisfied these assumptions and how the assumptions have been tested are all examined. The analysis also investigates the direction of the bias when assumptions are violated.

Another area of the estimation of the stock size that has not been adequately addressed is the method by which the estimated whale abundances for the sampling periods are expanded to the total migration period. This is commented on, in particular how it affects the variance estimate of the population estimate.

Assumptions of the single mark release method

Seber (1982, p. 59) outlines the six assumptions of the single mark release method for population abundance estimations. These are: 1) The population is closed; 2) All animals have the same probability of being marked; 3) Marking does not affect the future recapture of the animal; 4) The recapture is a simple random sample of the population; 5) Marks are not lost between samplings; and 6) All marks are found in the second sample.

Assumption 1. The population is closed.

A closed population means not only that the population size is constant within the sampling period, as explicitly noted in Seber (1982), but also that population size is constant because there are no deaths or births, as noted in Gentleman and Zeh (1987) and no emigration or immigration (White et al. 1982, p. 3). This latter point was not dealt with during the estimations of whale abundance (Gentleman and Zeh 1987; Zeh et al. 1988). Emigration and immigration should not be a serious problem, since the population of migrating bowhead whales is closed because the marking and recapture are nearly simultaneous events. However, there are biases due to the definition of the population that is being estimated, and possible double counting of the population.

The "population" estimated is the total number of cue tracks and not the number of whales. This is very different from the traditional use of single mark recapture population estimation. Generally, marks are fixed to a number of individuals that are then released back into the population to be estimated. A second sample is subsequently selected and the number of previously marked animals determined. In the application of the mark recapture estimation to bowhead whales, the marking and recapture occur concurrently and, thus, the cue that is used as the mark is not important. A cue track is produced when a whale is sighted or when it is detected by the hydrophone array. The visual cue track contains the sightings and resightings of what is thought to be a single whale passing the observation post. An acoustic track is formed when whale sounds located by the hydrophone array are linked by an acoustic tracking algorithm. The acoustic tracking algorithm takes the time and location of the calls and then clusters the calls into tracks based on assumptions made about possible swimming speeds and directions. Unlike the visual tracks, most acoustic tracks cannot be attributed to one whale. Recapture of the marked cue track occurs when the visual and acoustic tracks occur in the same location at the same time.

There is a possibility of double counting whales using the mark release method if sampling periods are determined in an arbitrary fashion. Double counting would occur when whales which entered during a sampling period and were detected but had not left the area by the end of the period, were redetected during the next sampling period. While the method used to minimize this possibility is not explicitly outlined in the 1988 or 1989 methods (Zeh et al. 1988a, b, 1989), it can be inferred from Raftery et al. (1988) that the sampling periods were separated by times when few or no whales were within the observation area.

The bias involved with the assumption of closure of the population is expected to be neutral. However, there is a significant bias associated with the assumption that cue tracks are whales. The direction of this bias is not clear, but there is a possibility that more than one acoustic cue track will be generated from the sounds made by a single whale. Comparison of the tracking algorithm's estimate of tracks with the acoustic tracks thought to be from individual whales based on visual and acoustic cues have constantly required updating of the tracking algorithm (Zeh et al. 1989). The concordance between whales and cue tracks that results from this iterative procedure of parameter selection is not based on empirical information. The true relationship between cue tracks and whales is unknown, and thus the abundance estimate from acoustic and visual tracks should be considered an index of the population abundance with an unknown relationship with the actual abundance of whales (Caughley 1977, p. 15). Quotas should reflect this uncertainty.

Assumptions 2, 3, 4, 5, and 6. All animals have the same probability of being marked, marking does not affect the future recapture of the animal, recapture is a simple random sample of the population, marks are not lost and all marks are found in the second sample.

These five assumptions are violated in the estimation of bowhead whale tracks due to the non-random distribution of the marked and recaptured samples. These non-random distributions are associated with the different distances at which whales are likely to be seen or to be detected by the hydrophone array.

The "initial" capture of whale tracks occurs in a markedly different area than the recapture. For ease of description, it is assumed that the whales seen from the shore-fast ice station receive the mark and the whales acoustically detected are the second sample. These two samples are not random samples of the whale population passing the observation point. Some whales surfacing are missed by observers (Krogman et al. 1989) and the further the whale is from the observation point, the greater the possibility that it will be missed (Burnham et al. 1980; Hammond 1984). This problem was addressed by limiting the observation zone to the area within 3.0 km of the observation station (Zeh et al. 1988b, 1989). However, even within this restricted region, whales further from the station were more likely to be missed. Most whales were seen within 1 km of the observation station, but most whales were heard at greater than 2 km from the observation station.

This non-random sample of marks was apparently overlooked by Gentleman and Zeh (1987), but given some thought later because the mark release sample was restricted to the 3 km adjacent to the observation platform and cue detection models were incorporated (Zeh et al. 1988b, 1989). Reliance on a detection model will not necessarily correct for the non-random nature of the two samples of the population of tracks. The distribution of whale cue tracks is a complex interaction between the whales' behaviour, ice conditions and spatial and temporal position during the migration. Radial aerial surveys (Hammond 1984; Nerini and Rugh 1986) should be considered as tests of the visual and acoustic detection models. These data have not been collected.

How does the violation of these five assumptions affect the abundance estimate of 'tracks'? Since recaptures will be fewer, due to the distribution of visual and acoustic cue tracks, the estimate of the "population" size of tracks is most likely an overestimate.

Conclusion based on the assumptions of the mark release experiments.

The estimates based on the mark release survey contain a positive bias due to the differences in the distribution of the visual and acoustic tracks. The magnitude of this bias cannot be determined from the published literature, but its size may be sufficiently large that a sustained harvest based the population estimate of tracks would be unwise.

The assumption that 'tracks' are equal to whales is likely to also overestimate the actual number of whales. A subsequent mark release survey that addressed some of these biases using detection models has produced a lower population estimate of 6 700 tracks with a standard error of 1 100. But it was unclear whether this lower estimate was due to the correction of positive biases, or due to differing numbers of whales heard and seen.

Review of the sampling design

The estimates of cue track abundance do not represent the population estimate accepted by the I.W.C. Some time periods were not suitable for observation, and thus required extrapolation to account for cue tracks passing during times of incomplete data. In addition, a number of correction factors were used to alter the cue track estimate to the number of whales. These practices require the application of a sampling design; however, no design was explicitly outlined. It appears that the most appropriate would be a post hoc application of a stratified random or systematic sampling design without replacement of sampling units, incorporating ancillary information by ratio and regression estimates (Som 1973). This would allow the incorporation of the variance or uncertainty associated with the ratios or correction factors, as well as the variation between sampling units into the variance estimates. This would increase the variance of the final estimate.

Overall conclusions

Until biases associated with the mark release (capture/recapture) model using visual and acoustic cues have been more fully investigated and validated (new data needed), AFSAC will accept the mark recapture estimate based on sightings alone. The largest estimate based on visual sightings alone was 4 417 (95% C.I.= 2 613 to 6 221) (Anonymous 1986). This number is an underestimate because it does not account for whales that pass too far from shore to be seen.

REPORT OF THE AFSAC MARINE MAMMAL SUBCOMMITTEE: 1990/91

INTRODUCTION

On February 19 - 21, 1991 at the Canadian Centre for Inland Waters in Burlington, a joint meeting of the Marine Mammals Subcommittees of the Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC) and the Arctic Fisheries Scientific Advisory Committee (AFSAC) was held. This was the first joint meeting of the Subcommittees from both AFSAC and CAFSAC and afforded an opportunity for broader scientific input into issues often of regional concern in marine mammal management. One stock (eastern Hudson Bay beluga) and one species (Bearded seal) were reviewed as part of the agenda brought forward by the Marine Mammals Subcommittee of AFSAC.

The CAFSAC Marine Mammals Subcommittee agenda items included grey seal, harp seal, hooded seal, harbour porpoise and St. Lawrence beluga. Reporting on the results of the reviews of these stocks will be as part of the normal CAFSAC process.

The review of Bearded seal was the first by AFSAC for this species. The report of eastern Hudson Bay beluga was an update of the review by the Marine Mammals Subcommittee of AFSAC the previous year. The following background reports formed the basis for the Subcommittee's deliberations:

Bearded seal. H. Cleator (AFSAC Document 90/91-01)

Eastern Hudson Bay Beluga: 1991 Update. T. Smith (AFSAC Document 90/91-07).

BEARDED SEAL

Introduction

This species of seal is important to the native subsistence hunt in the arctic. This review is the first for this species to be carried out by the Marine Mammals Subcommittee of AFSAC.

Background

Stock definition: Two subspecies have been identified: Erignathus barbatus (Erxleben 1777) in the eastern Canadian arctic and north Atlantic and Erignathus barbatus nauticus (Pallas 1811) in the western Canadian arctic and north Pacific. The exact boundary between the two subspecies is not well defined and debate on the subspecific status continues. Bearded seals in the Bering and Chukchi Seas make long migrations to remain close to the ice but such movements in Canada are short and local. There is, therefore, insufficient evidence to define more than one stock of bearded seals, but the species would be best managed on a "local community stock" basis, as local depletion is possible.

Stock size: Abundance estimates are scarce. Estimates made ancillary to ringed seal surveys in the southern and eastern Beaufort Sea range from 1 200 to 3 100. Earlier estimates of about 185 000 bearded seals in Foxe Basin, Hudson Bay, Hudson Strait and Ungava Bay cannot be validated and are out of date.

Vital parameters: There are no recent data from Canada. Estimates presented here are based on data from bearded seals in Canada and Alaska obtained in the 1960's and 1970's, from populations of unknown status:

Ovulation Rate: 46 - 100% of females over 5 years
Pregnancy rate: 33 - 86% of females over 5 years
First ovulation: 3 - 4 years
First pregnancy: 4 - 5 years

Many females do not conceive on their first ovulation.
Mortality Rates: unknown
Sex ratio (males:females) at birth: 1:1
Sex ratio (males:females) of adults: 1.2:1
Annual birth rate: 22% of population (based on harvest data only)
Finite rate of increase: unknown

Current harvest: Incomplete data from 1960 - 1980 suggested about 2 500 bearded seals were landed each year. Losses ranged from 25% to 50% depending upon the season. Total removal in Canada may have been between 2 500 and 7 000. Domestic use may have declined since the 1970's but current harvest levels are unknown and cannot be expressed as a percent of the total stock.

Other impacts: Predation by polar bears and, rarely, walrus has been documented but not quantified. Organochlorines and heavy metals have been reported in bearded seal tissue but the biological impact has not been examined.

Industrial activities could affect bearded seal numbers and vitality through direct injury or death (e.g. oil spills, vessel traffic) and disturbance (e.g. noise), or indirectly through alteration of their prey species and habitat (e.g. dredging). These are potential impacts which have not been studied.

Major issues

Stock status and expected trends in abundance cannot be assessed due to a lack of harvest and biological data. Industrial activity is potentially harmful (see above). There is also the potential for localized overharvesting.

Assessment

Stock prognosis: Given the limited information, a prognosis for bearded seal in the Canadian Arctic is not possible at this time.

Management recommendations

1. Harvest statistics should be collected by season, kill site and home community and include: number of landed animals, number of lost animals, gender, age group, and date of harvest.
2. Communities, including relevant settlements in Newfoundland and Labrador, should be surveyed to determine recent and present trends in harvest levels and level of domestic use of bearded seal products.
3. Collection of reproductive organs, tissues for ageing, standard body measurements and stomach contents should begin as soon as possible.
4. If losses during hunts are significant, hunting practices should be modified to ensure that struck animals can be retrieved.

Research requirements

1. Techniques for accurately estimating the densities of bearded seals, even in areas of low numbers should be developed. Once a suitable method is developed, a large scale survey of Canadian waters should be conducted to estimate total population size. This survey should be repeated as required to assess trends in abundance.
2. Biological and behavioural studies, including analysis of currently available samples and data, should be carried out to improve estimates of age-specific reproduction rates, assess density dependent variation in reproduction, assess natural mortality, and examine segregation in population structure.
3. An assessment should be made of landing and loss rates with respect to age group, gender, hunting method and season.
4. Hunted and non-hunted populations should be compared to assess population growth rates and suitable exploitation rates.

Next AFSAC review

Another AFSAC review should be done only after one or more of the research and management recommendations have been completed. There are currently no dedicated studies being conducted on bearded seals by scientific staff of DFO within the Central and Arctic Region.

EASTERN HUDSON BAY BELUGA (1991 UPDATE)

Introduction

This stock, listed as threatened by COSEWIC, was reviewed in February, 1990, by the AFSAC Marine Mammals Subcommittee at the request of Quebec Region of DFO. A recommendation by the Subcommittee arising from that review was that an update be made in 1991, when data on the 1990 harvest was available. This report is based upon updated 1990 information.

Background

Stock definition: This stock has usually been called the Eastmain stock (Reeves and Mitchell in press), however, eastern Hudson Bay more appropriately defines its summering range which extends from James Bay north to the Nastapoka River and west at least as far as the Belcher Islands. The southern and western limits of the range are somewhat arbitrarily defined. The relationship between whales of James Bay and those of eastern Hudson Bay is not known. Surveys indicate a continuous summer distribution of belugas from western Hudson Bay through James Bay to eastern Hudson Bay (Smith and Hammill 1986; Richard et al. 1991). Reeves and Mitchell (1987b) suggest that, although James Bay and eastern Hudson Bay whales may be one biological stock, they should be treated as separate stocks for management purposes. A conservative management approach is to consider belugas from eastern Hudson Bay and James Bay to be of different stocks until new information indicates otherwise.

The Nastapoka and Little Whale Rivers are the primary summering areas of this stock. Historically, large concentrations were also found in the Great Whale River, but this estuary is no longer used (Reeves and Mitchell 1987b; Smith and Hammill 1986). Whales begin to arrive at the summering areas in late June and leave in September (Reeves and Mitchell 1987b), presumably wintering in Hudson Strait (Finley et al. 1982).

Stock size: The most recent systematic survey of eastern Hudson Bay (Smith and Hammill 1986) estimated a mean stock size of 1 442 (95% Confidence Interval = 1 124 to 1 904), not including submerged animals. This survey was stratified, sampling both inshore and offshore habitat. Coverage did not include areas north of the Nastapoka River because local hunters indicated that whales were not seen in this area during the summer. This estimate is larger than the one previously obtained by Finley et al. (1982), which indicated fewer than 350 whales, however, Smith and Hammill (1986) included offshore areas to the Belcher Islands which had not previously been surveyed.

Vital parameters: Demographic parameters based on belugas harvested primarily at the Nastapoka are now available (Doidge, Makivik Corp., Kuujjuaq, Quebec, 1991).

Mean age of sexual maturity: 6+ years
Mean length of sexual maturity: 290+ centimeters
Sex ratio of harvested males to females: 146:147
Duration of gestation: 12.8 months

Complete breeding cycle:	3.25 years
Annual birth rate:	Not available
Finite rate of increase:	No independent estimate

Current harvest: Harvest data indicate an average of 117 whales were landed each year between 1978 and 1985. In 1986, 58 whales were landed. In 1987, a voluntary quota of 60 landed whales from eastern Hudson Bay and 60 landed whales from Hudson Strait was set for eastern Hudson Bay communities. In 1989, 79 whales were harvested in eastern Hudson Bay and 267 whales were harvested in Hudson Strait (Olpinski 1990). The proportion of eastern Hudson Bay whales taken in the Hudson Strait harvest is unknown. In 1990 the harvests and revised quotas were:

	Landed Harvest			Total	
	Min	Max	Lost	Removal	Quota
Eastern Hudson Bay	51	74	1	75	50
Hudson Strait	57	85	3	88	118
Ungava Bay	21	25	5	30	50*

(* to be taken outside Ungava Bay)

Other impacts: As with other stocks wintering in Hudson Strait, commercial fisheries for shrimp could deplete food resources used by these whales.

The province of Quebec has plans to develop major hydroelectric projects on the Nastapoka, Little Whale and Great Whale Rivers. Changes in the flow rates, ice patterns and mercury levels could affect whales that use the Little Whale and Nastapoka estuaries in summer and feeding areas in Manitounuk Sound.

A new settlement has been established at Umiujak, relocating hunters from Kuujjuarapik (on the Great Whale River) closer to the Nastapoka River where there is access to beluga whales. This new settlement could increase hunting pressure on this stock.

Major issues

Overharvesting: The total harvest from eastern Hudson Bay might be close to sustainable yield. Occasional high harvests from Hudson Strait as seen in 1989 could impact the eastern Hudson Bay stock generally. Ice entrapments which can occasionally cause high mortality are also a threat. No unbiased estimates exist for population growth rates, with 3 - 5% given as an approximation. No unbiased mortality estimates are available to confirm these percentages. A conservative strategy for management should be based on the lowest population estimate and err on the low side for growth rates.

Habitat modifications: Habitat modification from the Grande Baleine project will directly affect the Manitounuk Sound area which might be an important belugas feeding habitat.

Assessment

Stock prognosis: Given the uncertainty about estimates of stock size and vital rates, this stock might be stable, but additional information is needed in view of the fluctuating harvest levels. New hydroelectric projects scheduled for the Little Whale and Nastapoka Rivers, the last remaining estuarine concentration areas, could seriously endanger the stock if they result in a detrimental effect on belugas habitat.

Management recommendations

1. Given the current estimated stock size (1 442 with 95% Confidence Interval of 1 124 - 1 904), total allowable removal (TAR), including whales struck and lost should not exceed 48 whales annually. A low risk level of removal, calculated by multiplying the minimum estimated population size (1 124) by an arbitrary average finite rate of increase (2.5%), is 28 whales. A moderate risk level of removal is 1 442 x .025 = 36 whales. The low risk TAR is believed to have a low probability of causing a decline in stock size. Removal of fewer than 28 whales will likely permit the stock to increase in numbers.
2. Hunters should be encouraged to avoid striking females with calves to maintain the reproductive capacity of the remaining stock.
3. Large grey animals which have been found to be sexually mature and have the highest reproductive value to the population should also be protected.
4. Struck and loss rates should be estimated at both inshore and offshore locations such as the Belcher Islands. Harvesting conditions could differ from areas adjacent to the mainland and loss rates may differ accordingly. Total allowable removal includes lost animals, thus good estimates of loss rates are needed to ensure that the TAR is not being exceeded.

Research requirements

1. A satellite tagging project should be developed to provide information on the location of wintering areas and the relationship between eastern Hudson Bay and James Bay whales. Tagging will also provide information on feeding behaviour and could be used to address concerns about impacts of fisheries on summer and winter food resources.
2. Analysis of nuclear DNA from biopsy studies, would enhance the understanding of the mating system and permit estimation of the amount of genetic interchange that occurs between stocks in the wintering areas. This type of information is of value in developing recovery plans for depleted stocks and in estimating minimum viable population size of stocks.
3. Samples should be obtained from whales harvested in the autumn from the Hudson Strait villages. These samples will be used once the mitochondrial DNA analysis technique has been

completely developed to identify which stock these harvests are related to.

4. The southern part of the summering range, outside of the Nastapoka and Little Whale Rivers should be evaluated ecologically and its relative importance to the belugas assessed. This information is needed to determine how habitat degradation will affect the future status of this stock. The Little Whale River estuary and Manitounuk Sound are especially important.

5. Areas of aggregation in James Bay should be sought to identify potential study sites for work on the relationship between this and other Hudson Bay beluga stocks.

Next AFSAC review

Another AFSAC review should be done only after one or more of the management and research recommendations have been completed.

REPORT OF THE AFSAC FISH SUBCOMMITTEE: 1989/90

INTRODUCTION

The 1989/90 meeting of the AFSAC Fish Subcommittee was held on 14 March 1990. Membership of the Fish Subcommittee in 1989/90 consisted of the following:

D. Bodaly	(Science, Central and Arctic Region), chairperson
R. Crawford	(Science, Central and Arctic Region)
J. Flannagan	(Science, Central and Arctic Region)
A. Kristofferson	(P&FF, Central and Arctic Region)
R. Morin	(Science, Quebec Region)
J. Reist	(Science, Central and Arctic Region).

At that meeting, the Subcommittee considered the following reports:

- Quota Recommendations for Commercial Fisheries of Anadromous Arctic Charr, Northwest Territories, 1990/91. A.H. Kristofferson, G. Low, D. Pike, and P. Lemieux. (AFSAC Document 89/90-13).

- A Preliminary Analysis of the 1988 Cumberland Sound Iceland Scallop Fishery. R. Crawford and D. Pike. (AFSAC Document 89/90-08).

- An Overview of the Commercial Fisheries for Anadromous Arctic Charr in the Keewatin Region, Northwest Territories. A.H. Kristofferson, G.W. Carder, D.K. McGowan and D.G. Pike. (AFSAC Document 89/90-14).

- The Biology of the Iceland Scallop and Its Implications for the Management of an Arctic Fishery. R. Crawford and C. Hudon. (AFSAC Document 89/90-07).

- Stock Status of Arctic Charr in the Hornaday River, Northwest Territories. P.J. Lemieux and A.H. Kristofferson. (AFSAC Document 89/90-12).

- Update on the Baffin Island Turbot Fishery. R. Crawford. (AFSAC Document 89/90-09).
- Greenland Halibut Allocation: Baffin Region. D. Pike. (AFSAC Document 89/90-09A).

- Lake Whitefish (Coregonus clupeaformis) in the Lakes Involved in the Experimental Cropping of Lakes Project. E. Gyselman. (AFSAC Document 89/90-04).

- Stock Status of Arctic Charr in the Kagluk River, Northwest Territories. P.J. Lemieux. (AFSAC Document 89/90-10).

- Stock Status of Arctic Charr in the Rat River, Northwest Territories. P.J. Lemieux. (AFSAC Document 89/90-11).

Because of budgetary constraints, R. Morin could not attend the meeting. Written comments from Mr. Morin were received and incorporated into AFSAC recommendations.

In addition, the Subcommittee met on June 27, 1990 to consider an urgent request from the Regional Director, Fisheries and Habitat Management, regarding a request to conduct a commercial whitefish fishery in the Mackenzie Delta. Because of the urgency of the request and prior commitments of most of the Subcommittee, only three members were able to attend this meeting and contribute to the Subcommittee's response. Those members in attendance were D. Bodaly, A. Kristofferson and J. Reist.

The Subcommittee's mandate was to examine the foregoing reports on the stocks under review, report on the current status of stocks under examination, recommend rates of exploitation and other management policy based on present data and recommend aspects of research needed to improve the management of the stocks.

GENERAL COMMENTS

The Subcommittee has recommended that a formalization of report formats for documents prepared for and by AFSAC Subcommittees take place. These recommendations are included as Appendix 5. Some of the terms used in the following report are defined in a glossary included as Appendix 4.

The Subcommittee thanks all those involved in the preparation of the background reports for their untiring efforts. It recommends, and urges strongly, that these documents be prepared for publication in the Canadian Fisheries and Aquatic Sciences Technical Report series, or other suitable publications, if and when appropriate.

The following sections summarize the review of the background documents, and provide a statement of the conclusions and recommendations of the Fish Subcommittee.

ICELAND SCALLOP - CUMBERLAND SOUND

Introduction

The discovery of Iceland scallops (*Chlamys islandica*) in Cumberland Sound in 1983 and 1984 during exploratory fishing for groundfish sparked interest in developing a commercial fishery for scallops in the Pangnirtung area. Exploratory fishing for scallops since 1986 has revealed the presence of a number of beds in the Pangnirtung area and parts of Cumberland Sound. Two vessels, one a dedicated scallop dragger, investigated about 70 coastal areas in Cumberland Sound from 19 July to 28 September 1988, for the presence of Iceland scallops. Two promising areas were found near the community of Pangnirtung. Both vessels then participated in a commercial fishery from 29 September to mid-November on these latter grounds. They harvested a total of 17.2 tonnes of scallops using Digby-type drags. The catch produced 1.58 tonnes of meats.

Because of the success of the 1988 fishery, the Department of Economic Development and Tourism of the Government of the Northwest Territories withdrew its subsidy of this fishery, leaving it to demonstrate economic viability without financial support. In response, only one vessel participated in the 1989 fishery. The provisional quota for Cumberland Sound was 100 tonnes. The participating vessel was plagued with logistical and mechanical problems throughout the season and, ultimately, was damaged in a storm. Consequently, the total 1989 harvest fell to just 8.0 tonnes (round weight).

This review was made as a result of the recommendation by the AFSAC Fish Subcommittee when this stock was first reviewed in 1988/89 and there was an anticipation of greater harvests and increased biological data available.

Background

Stock definition: For fishery management purposes the scallops in Cumberland Sound are considered to be a separate stock from those in Ungava Bay. Within Cumberland Sound, the modal height of scallops caught near the Kikastan Islands was larger than that for scallops taken in the mouth of Pangnirtung Fjord. Therefore, the data from both locations were treated as though they were representative of two discrete stocks and are dealt with as two separate stocks (Kikastan Islands and Pangnirtung Fjord) in this report.

Stock size: An estimate of the unexploited recruitable biomass was derived by applying the average number of scallops caught per unit of swept area fished to the total area of the two scallop beds fished in Cumberland Sound. By area, these estimates are:

Pangnirtung Fjord	68 tonnes
Kikastan Islands	22 tonnes

When adjusted for sampling efficiency of the fishing gear (20 percent was used), the population biomass estimates become:

Pangnirtung Fjord	340 tonnes
Kikastan Islands	110 tonnes
Total	450 tonnes

Another estimate, using the length-frequency distribution, produced an estimate of 582 tonnes. Using a round weight-to-meat weight conversion factor of 10 percent, this represents about 58 tonnes of commercially shucked meats. Caution must be exercised when these estimates are used, due to the assumptions made in the process. The actual population size is probably between the extremes (90 - 582 tonnes).

Vital parameters:

	Pangnirtung Fjord	Kikastan Islands
Modal Height (mm)	72	80
Mean Height (mm)	75	79
Asymptotic Length (mm)	100.1	122.0
Asymptotic Weight (g)	121.6	220.9
Brody Growth Coefficient	0.090	0.073
Age at Length = 0	1.342 yr	1.054 yr
Instantaneous Total Mortality	0.37	0.57

Current harvest: Following is the harvest record of the Cumberland Sound scallop fishery:

YEAR	QUOTA (MT)	HARVEST (MT)
1988	100	17.2
1989	100	8.0

Other impacts: None identified.

Major issues

An economic analysis of the 1988 fishery by the Economics Branch of the Department of Fisheries and Oceans indicated that operating costs were too high for the fishery to ever be more than marginally successful under near-ideal conditions. The lack of enthusiasm generated by the 1989 fishery underscores the importance of federal-territorial subsidies to this fishery. Without further government support, this fishery is unlikely to continue.

Assessment

Stock prognosis: Management options for this fishery include: 1) pulse fishing, where the stock is fished to economic extinction and 2) sustained yield fishing, whereby exploitation is limited to a level that results in a total mortality rate within the stock that can be accommodated by recruitment and production. The Cumberland Sound Scallop Management Plan has adopted the sustainable yield approach.

The Beverton-Holt yield-per-recruit analysis was applied to the data collected to date. The data were fitted to a Walford plot which showed that the Brody-von Bertalanffy (1938) relationship satisfactorily described the growth of the two Cumberland Sound scallop stocks. For the Pangnirtung Fjord stock, yield-per-recruit (YPR) was maximized (1.57) at F=0.8, although F values of 0.5 to 1.9 all generated a YPR of 1.5. For the Kikastan Islands stock, YPR was maximized (1.06) at F=1.9, but was maintained at 1.0 with

F values of 0.9 to 1.9. The method of Beddington and Cooke was used to estimate the yield of the Cumberland Sound scallop stocks.

For the Pangnirtung Fjord stock, maximum sustained yield (MSY) at F=0.8 is 41-47 tonnes (0.12 of the unexploited recruitable biomass), assuming recruitment at age 6 years (30 mm). With recruitment at 60 mm, MSY is 61-70 tonnes (at 0.18 of the unexploited recruitable biomass). At F=1.9, values are 0.12 and 0.19, respectively, providing yield estimates of 41-47 tonnes and 65-74 tonnes, respectively.

Estimated MSY for the Kikastan Islands stock at F=1.9 is 22-38 tonnes (0.20 of the recruitable biomass) assuming recruitment at age 6 years (30 mm) or 26-46 tonnes (0.24) if recruitment occurs at 60 mm. Similar estimates at F=0.8 are 20-35 tonnes (0.18) and 26-46 tonnes (0.24), respectively.

The reliability of these estimates is subject to the validity of the assumptions made in the analysis and must therefore be used with caution. The estimators used in this analysis all assume equilibrium conditions: constant recruitment and constant mortality. Virtually nothing is known about recruitment to the Cumberland Sound scallop stocks and the convex catch curves indicate mortality is not constant, but increases with age. The point of the analysis was not to derive definitive estimates to be used in the management of the fishery because the available data are insufficient to do so. Rather, first order estimates of yield have been generated which will help to define data gaps and the precision necessary for future data collection. With more data, it will be possible to refine these estimates of production and yield.

Although these analyses are preliminary, they do reveal a slow rate of growth for Iceland scallop stocks in Cumberland Sound. The resources identified to date on the two beds discussed do not provide a resilient base on which to establish a long-term Arctic fishery. Efforts to locate additional beds in Cumberland Sound should continue. If results confirm that the current targeted beds are the only commercially viable grounds in the Sound, then fishing effort should not be significantly expanded, if sustained annual yield remains the management objective.

Management recommendations

1. The current provisional quota should remain at 40 tonnes round weight for the Pangnirtung Fjord and Kikastan Islands beds combined, and 60 tonnes round weight for the remainder of Cumberland Sound (total of 100 mt).
2. For the present, the Cumberland Sound Iceland scallop fishery should be managed on a sustained yield basis.

Research requirements

1. Efforts should continue to locate additional beds of Iceland scallops in Cumberland Sound. Accurate mapping of the true extent of the beds is necessary. Catch per unit of effort data, in combination with accurate geo-positioning data, will greatly improve population estimation.
2. Biological data must be collected from commercially-fished and new beds each year to establish a data base for stock assessment purposes. Large samples (greater than N=3000) of length data are needed from each harvested bed. The samples should be taken with covered or lined gear to minimize escapement. Specimens representing the entire size range, with replicates in each size class, should be collected from each bed. Samples should be taken each year to determine the age composition of the catch. Sample size for ageing should be at least 350 individuals. Underwater video photography should be considered to locate juveniles.
3. Studies of the life history of Iceland scallops in Cumberland Sound should be initiated. These studies should include biological and physical oceanographic characteristics responsible for distribution and abundance, mechanisms for larval transport and retention, population mixing and stock fidelity, the position of the scallop in the benthic community, and population dynamics necessary to develop a model for commercial exploitation.
4. Further exploration for scallops in Hudson Strait, Hudson Bay and Baffin Island waters should focus on areas of high water mixing. Survey plans should accommodate the lack of bathymetric information for the eastern Arctic and should utilize vessels of a size that can safely work in uncharted waters.

Next AFSAC review

The next review should take place following any commercial fishing season, should one take place.

THE BIOLOGY OF THE ICELAND SCALLOP AND ITS IMPLICATIONS FOR THE MANAGEMENT OF AN ARCTIC FISHERY

Author's abstract

This report contains a synoptic description of the biology of the Iceland scallop (Chlamys islandica) which is derived mainly from information of the species in Norwegian waters. The report examines how Iceland scallop biology relates to Arctic fishery management objectives and fishery development goals. The Iceland scallop is a mollusc (Class Bivalvia) that can swim, but usually attaches itself to the substrate with byssal threads. It is known from depths of 18 - 327 m, but its local depth range is often much narrower (e.g. <50 m). It is found in salinities as low as 22.5 o/oo. The Iceland scallop has a well developed sensory system and a specialized feeding mechanism that filters particles as small as 0.007 mm; particles too large for its feeding apparatus are rejected. The quality of its food is determined by the ratio of particulate organic matter (POM) to

particulate inorganic matter (PIM). A minimum ratio of 33% is required for growth. Growth is seasonal and can be highly variable within a localized area. Scallop growth in the Canadian Arctic is consistently slower than for those living in the Gulf of St. Lawrence, although this comparison involves two different species.

Recruitment of Iceland scallops is uneven and a population of scallops is often dominated by cohorts of relatively few year classes. Natural mortality of larvae and juveniles is high and survival of cohorts of a new year class fluctuates according to the influence of many environmental and biological variables. Young scallops may settle to the bottom away from populations of adults and later migrate there. The local distribution of Iceland scallops is patchy and they can exploit even marginally favourable habitat, especially after a highly successful year class.

Management recommendations

The implications of the Iceland scallop's biology to Arctic fishery exploitation and development are:

1. Exploratory fishery development requires that large areas must be thoroughly surveyed in order to accurately assess the extent and biomass of an Iceland scallop resource.

2. Differences in quality of local areas as scallop habitat results in variation in growth rate, mortality, size, and meat yield.

3. Slower Arctic growth rates, coupled with shorter growing and fishing seasons, limit the opportunity for a fishery to exploit the scallop's post-reproductive season growth spurt, if such a growth spurt even exists for Arctic populations.

4. Slow growth rates and variable mortality rates limit the exploitation potential of Iceland scallops in the Arctic.

5. Off-bottom culture has potential because of longer availability of high quality food in the water column.

6. Distribution is patchy, but scallops are mobile and will exploit marginally favourable habitat, albeit often in concentrations too low for adequate economic return to a fishery.

Research requirements

Recommended areas for further study are:

1. Examination of the distribution and abundance of this species, and the biological and physical determining factors.

2. Examination of the linkage between phytoplankton production and the maturation of Iceland scallop gonads, production of planktonic larvae, and production of the adult benthic population.

3. Determination of mechanisms for larval transport and retention, population mixing and stock fidelity.

4. Examination of the position of the Iceland scallop in the benthic community.

5. Determining the effect of exploitation on population dynamics in a virgin stock and developing models for commercial fishery exploitation.

6. Determination of aquaculture potential.

BAFFIN ISLAND TURBOT FISHERY

Introduction

Development of the Baffin Island inshore fishery for turbot (Reinhardtius hippoglossoides), also known as Greenland halibut, began in the spring of 1986 in Cumberland Sound, near the community of Pangnirtung. The fishery took place in March using long lines through the ice, and 186 fish were harvested over a period of a few days. In the spring of 1987, the Pangnirtung Hunters and Trappers Association harvested 4 100 kg of a 6 000 kg provisional quota. Most of the harvest was marketed in Montreal and Ottawa. In 1988, the Baffin inshore fishery was allocated 100 tonnes of the 3 000 tonne Canadian quota for NAFO AREA 0, of which 50 tonnes were reserved for the Pangnirtung fishery. The latter harvested 10 600 kg (10.6 tonnes). In 1989, the Pangnirtung fishery produced a harvest equal to the entire 100 tonne inshore allocation by the end of April and, after an additional allocation of 100 tonnes was obtained, this fishery harvested another 80 tonnes by the end of May. An experimental summer fishery, conducted in the same location as the spring through-ice fishery, produced only 7 kg.

Based on results to the end of the 1989 season, the Baffin inshore fishery was allocated 200 tonnes for the 1990 season, of which 160 tonnes was reserved for the Pangnirtung fishery and the remaining 40 tonnes for other Baffin Island communities which have recently shown interest in developing similar fisheries in their areas.

Background

Stock definition: Presently it is assumed that the Pangnirtung fishery harvests a migratory portion of the Davis Strait stock that occupies Cumberland Sound seasonally. Growth rate of turbot sampled from the Cumberland Sound catch is similar to that of turbot caught in trawls in Davis Strait. There is, however, the possibility that this fishery exploits a discrete stock of turbot which occupies Cumberland Sound in winter and migrates elsewhere in summer. The migration theory is based on the success of the through-ice fishery compared with the failure of the summer fishery.

Stock size: Virtually nothing is known about the size of the stock that seasonally inhabits Cumberland Sound. A minimum trawlable biomass of 282 000 tonnes has been estimated for NAFO areas

0 and 1. A quota of 25 000 tonnes has been assigned to this area. As previously stated, the Canadian sub-allocation for NAFO AREA 0 is 3 000 tonnes.

Vital parameters: A detailed analysis of biological data collected to date on turbot from the Cumberland Sound fishery is currently in progress. Results will be presented at a later date.

Current harvest: The following is the harvest record of the Cumberland Sound turbot fishery:

Year	Quota (MT)	Harvest (MT)
1987	6	4.1
1988	100	10.6
1989	200	180.0

The catch per unit of effort (CPUE) in 1987 was 0.098 fish per hook hour (N = 112), for a catch of 4.1 tonnes in 1987, compared with 0.090 (N=826) in 1989 for a catch of 180 tonnes.

Other impacts: None identified.

Major issues

The success of the Pangnirtung fishery to date has generated significant interest within that community to expand the fishery. The processing facilities are presently nearing capacity and plans include building a new plant in 1992. Other communities on Baffin Island are (or soon will be) carrying out exploratory fisheries for turbot in an effort to develop fisheries of their own. This will result in an increased demand on the resource. Research is necessary to determine the stock status of turbot in the inshore areas of Baffin Island such that the fisheries can develop into a sustainable industry.

Assessment

Stock prognosis: The regional Cumberland Sound groundfish management strategy is to monitor CPUE as a measure of the impact of fishing on the turbot stock. It is noted that in spite of the increase in the harvest from 4.1 MT in 1987 to 180 MT in 1989, the CPUE remained constant at 0.90 fish per hook hour. An unchanged CPUE suggests that, for the brief period in question, fishing mortality has not had a significant negative impact on the resource. The CPUE will be monitored during the course of harvesting the 160 tonne quota for 1990. If it does not decline, a request for an additional quota will be supported by AFSAC. It is not anticipated that the harvest will exceed 250 tonnes for 1990. A provisional quota of 10 tonnes for each of the communities of Clyde River, Iqaluit, Broughton Island and Cape Dorset has been allocated to train fishermen in the ice-platform techniques that have been successfully utilized by the Pangnirtung fishery.

Available evidence suggests that the Baffin Island inshore fishery is exploiting the underutilized Davis Strait turbot stock. A request will thus be made to the Atlantic Groundfish Advisory Committee to sub-allocate 2 000 tonnes (of the Canadian allotment of 3 000 tonnes) to the Baffin Island inshore fishery to accommodate future expansion.

Management recommendations

1. The CPUE for the Pangnirtung fishery must be monitored to determine the effect that the present level of fishing (160 tonne quota) is having on the stock. If results show no decline in the fishery, AFSAC will support a request to increase the Pangnirtung quota to 250 tonnes for 1990. Present processing/transportation capabilities suggest an upper limit of 250 tonnes.
2. A program to collect CPUE data from the other developing Baffin Island turbot fisheries should be initiated.
3. A request should be made to the Atlantic Groundfish Advisory Committee for a sub-allocation of 2 000 tonnes (of the Canadian allotment of 3 000 tonnes) of turbot for the Baffin Island inshore fishery.

Research requirements

1. Biological data should be collected annually from all Baffin Island inshore turbot fisheries for stock assessment purposes.
2. Research should be initiated to clarify the stock status of turbot vulnerable to fisheries in the inshore waters of Baffin Island. This work should be done in cooperation with the Newfoundland Region of the Department of Fisheries and Oceans since that region manages the Davis Strait turbot stock.

Next AFSAC review

A background document on the status of the Cumberland Sound turbot fishery should be prepared for review by AFSAC in February, 1991.

LAKE WHITEFISH IN CHITTY LAKES

Author's abstract

The Experimental Cropping of Lakes (ECOL) project has been experimentally harvesting lake whitefish (Coregonus clupeaformis) from four small lakes also known as the Chitty lakes, 20 km NNE of Yellowknife, since 1971. Because of their limited stock size, these lakes have little potential for either a domestic or commercial fishery. The isolated location of the lakes also minimizes sport fishing, making them well suited for experimentation by DFO. Two major croppings have taken place: 1973-74 and 1985-89. A total of 9 724 kg of whitefish was removed from the lakes in the 1973-74 program and 7 191 kg in the 1985-89 program.

The lakes harvested at rates greater than existing recommended quota for lake whitefish in the Northwest Territories, 0.5 pounds of fish per acre (0.56 kg per hectare)• showed evidence of over-exploitation. Therefore, although the results from the study are not yet complete, the existing quota guideline seems reasonable for lakes of this size.

Recovery of the whitefish stocks in the experimental lakes can be expected to take approximately 10-12 years, if left undisturbed.

A minimal test netting to determine the status of the stocks will be carried out in 1990 and 1991. DFO plans to dispose of the facility at the end of 1991.

General recommendations

1. Tentative nature of report conclusions
The Fish Subcommittee noted that the background report (1989/90-09) was based on a preliminary analysis of an incomplete data set. Crucial portions of data such as age results were not available at the time of writing and the final years of monitoring have not been completed. The conclusions in the background report and the recommendations in this report must therefore be regarded as tentative. An updated background report should be prepared when data analysis for the complete project is finished. A parallel data set to the lake whitefish results on lake trout population responses to exploitation has been collected. A background report on lake trout should be prepared when data analysis for the complete project is finished.

2. Future plans of ECOL project
The current plan for population monitoring for a further two years with closure of the facility after this time is supported by the Fish Subcommittee. The purpose of the monitoring is to determine whether enhanced juvenile recruitment continues after harvesting is completed, not to observe population recovery.

3. Transferability of conclusions to other lakes
Great caution must be exercised in transferring the results of this research project to lakes of larger size or differing limnological and biological characteristics. Factors such as lake size, mean depth, proportion of littoral area to total lake area, nutrient levels and fish species composition may affect the harvest levels which can be sustained by whitefish populations. It would be useful in future reviews of whitefish fishery management to present data in terms comparable to those presented in this background report, so that direct comparisons can be made.

4. Early signs of over-exploitation:
An important implication of the results of the ECOL study for fisheries management practice is the recognition of characteristics of fisheries which can serve as early warning signals of over-exploitation. Although not all ageing data was available to the author at the time of the writing, it appeared that mean age of the catch from harvest (commercial sized) nets did not provide information related to the rate of exploitation. On the other hand, catch-per-unit-of-effort (CPUE) in harvest nets did show a dramatic decline in lakes which were heavily exploited. This finding points to the utility of accurate CPUE statistics as a tool for monitoring the status of whitefish fisheries. While CPUE showed large daily variation, means of data taken over a whole season appeared to show meaningful trends. Therefore, harvest statistics of CPUE would be most useful if collected continuously or at least at various times over an entire commercial fishing season. Final project results should be examined for confirmation of this tentative conclusion and for the possibility that other population characteristics may serve as early signs of over-exploitation.

5. Implications for pulse fisheries
The ECOL project results also have implications for the practice of pulse or rotational fishing of whitefish populations in small, northern lakes. It would appear that there is little chance of changing the relative abundance of various species in such lakes by cycles of short-term heavy exploitation and periods of recovery. The monitored recovery of the whitefish populations in the ECOL study lakes showed that whitefish population size and relative species abundance had changed little after recovery from the earlier experimental harvests.

ARCTIC CHARR - HORNADAY RIVER

Introduction

The Hornaday River drains into the Amundsen Gulf region of the eastern Beaufort Sea (See Fig. 1), about 10 km east of the community of Paulatuk. It is within the Inuvialuit Settlement Region. Only the lower 45 km of the Hornaday River is available to anadromous charr because of a 23 m waterfall blocking further passage upstream. Arctic charr of the eastern form have been fished for many years by residents of Paulatuk as part of the domestic fishery.

Commercial fishing began in 1968 with a quota of 2 300 kg. This was raised to 4 500 kg in 1974, and to 6 800 kg in 1976. This level of exploitation proved to be unsustainable and catches declined in the early 1980s. The commercial fishery was closed in 1987.

A small sport fishing lodge was established on the Hornaday in 1972, but languished after two years.

Background

Stock definition: The Hornaday stock of Arctic charr is assumed to be genetically distinct from other stocks. In summer the anadromous charr frequent the waters of Darnley Bay, but the extent of their movement is not known. Arctic charr are known to inhabit the Brock River, 30 km to the east, but the extent of mixing of the stocks is unknown.

Stock size: An attempt was made to enumerate the upstream run of Arctic charr in the Hornaday River in 1986 by means of a weir. A total of 10 798 charr were counted between August 9 and August 28 when the weir collapsed. Based on this count, it was estimated that the stock probably didn't exceed 16 000 charr. A stock size of 11 000 was conservatively used for the calculation of recommended harvests.

Vital parameters: Modal length of Arctic charr samples during the count in 1986 was 400-450 mm, and ranged from 200 to 693 mm. Results from monitoring the 1989 domestic fishery revealed that the modal length was significantly higher at 550-599 mm, but this was probably due to biased samples. The mean ages of migrating charr sampled in 1986, 1987 and 1989 was 7, 8 and 7.6 years respectively.

Instantaneous total mortality (Z) was calculated from the catch curves from the 1986 and 1989 data. Values for Z from the two sampling seasons were 0.40 and 0.48 respectively. These figures should be interpreted very cautiously since the 1986 age-frequencies were calculated from the length-frequency distribution. Also, the 1989 calculated mortality rate is likely lower than the true value.

Current harvest: The commercial harvest in 1986 was 2 900 kg. The commercial fishery was closed in 1987. Records have only recently been kept for the domestic harvest of the Hornaday River charr. In 1988 the total domestic harvest from the Hornaday was 1 653 fish. For 1989 this figure is estimated to be approximately 2 200 fish.

Other impacts: Arctic charr remain very close to shore while feeding at sea. Widespread disturbances such as oil spills which would affect nearshore habitats could adversely affect Arctic charr stocks along the coast of Darnely Bay and Franklin Bay.

Major issues

The steady decline in the commercial harvest (and catch per unit of effort), as well as the small number (minimum 10 800) of charr counted in the run in 1986 led to a closure of the commercial fishery in 1987 due to suspected over-exploitation. It is believed that the continuing domestic harvest is in excess of a sustainable level and that the population will continue to decline. Alternate sources of charr should be found in order to facilitate the reduction of the harvest from the Hornaday, however, test fisheries carried out over the last two years suggest that nearby stocks are lightly exploited but are not large enough to support any significant commercial or domestic fishery.

Assessment

Stock prognosis: A steady decline in the commercial catch, low CPUE and small size of fish strongly suggest that the Hornaday River Arctic charr stock is being over-exploited. Current levels of exploitation are probably somewhere in the 15-20% range. The stock may not recover unless the domestic (subsistence) harvest is reduced to 5% of the stock size.

Management recommendations

1. No commercial fishing should be allowed on the Hornaday River until the population has recovered and it can be shown that the total allocation for domestic and commercial fisheries falls within the recommended TAC.
2. A fishing plan should be developed to ensure that the domestic catch is reduced to 5% of the stock.
3. The following are the recommended TACs based on low, medium and high risk levels:
   - i) Low Risk TAC - 0 harvest
   - ii) Medium Risk TAC - 550 fish (5% exploitation)
   - iii) High Risk TAC - 1 100 fish (10% exploitation)
4. Alternate sources of Arctic charr for the domestic fishery in Paulatuk should be sought.
5. The domestic harvest should continue to be monitored. Vital parameters should be monitored in cooperation with native users.

Research requirements

1. The size of the Arctic charr stock in the Hornaday River should be determined in the near future.
2. Stocks in the area should be identified using electrophoretic techniques.
3. A tagging program should be initiated to help identify mixing of local stocks.

Next AFSAC review

The next review should take place when new data is available on the size of the stock.

ARCTIC CHARR - KAGLUK RIVER

Introduction

The residents of Holman Island requested an increase in their commercial quota for sale to visitors. It was considered that the main source of charr in the area, the Kuujjua River, could not support an additional harvest. The Kagluk River was thought to be a possible alternative and therefore surveys were carried out at the Kagluk in 1985 and 1987. A weir was used to evaluate the stock in 1988. The Kagluk River flows into Prince Albert Sound on Victoria Island (see Fig. 1).

Background

Stock definition: Anadromous Arctic charr spawning and overwintering in the Kagluk River are believed to comprise a discrete stock. None of the fish tagged in the Kuuk River were recaptured in the Kagluk River and none of the charr tagged on the Kagluk River were recaptured in the Naloagyok River. Fresh and old gillnet marks observed on 3% of the charr entering the Kagluk suggests that these fish wander a considerable distance away from their natal stream, since most gillnetting takes place in the Safety Channel area nearly 100 km distant. Analyses of summer recoveries and of genetic and morphometric characteristics are underway.

Stock size: Between August 8 and September 5, 1988, a total of 1 878 charr were counted migrating upstream in the Kagluk River. The total upstream run is assumed to represent the total stock.

Vital parameters: Modal length from the 1988 sample was 600-650 mm and ranged from 200 to 850 mm. Average weight was 3.4 kg. Ages ranged from 4 to 19 years with the mode at 14 years. These values are not significantly different from the data collected during the 1985 survey. Instantaneous total mortality (Z) calculated for the ages 15 to 19 years was 1.04, according to the calculated age-frequency distribution of the run. Mortality calculated for the ages 14-16 years from the 1985 sample was Z = 0.55.

Age at first maturity was 14 years or younger for males and 12 years or younger for females, and the sex ratio was even (Female/Male = 1.02). The samples collected in 1985 indicated a Female/Male ratio of 0.65. Rate of recruitment is not known.

Current harvest: The test fishery at the Kagluk River in 1985 yielded 168 kg, or 56 charr. The trial fishery using a weir in 1988 during the time of the migration yielded 1 887 kg or 551 charr, which represents about 29% exploitation. Fresh gill net marks on some of the upstream migrants suggest that they are exploited to some extent by other coastal fisheries, presumably in the Safety Channel area. There may also be some harvest of the upstream spawning beds. The extent of the domestic fishery is unknown. There was no fishery in 1989 and 1990.

Other impacts: No serious impacts are identified at this time.

Major issues

No major issues are apparent at this time.

Assessment

Stock prognosis: The relatively high mortality rate and presence of net marks on the fish suggest that significant numbers of charr from the Kagluk River are already being harvested not only in the river but in other areas as well. In addition, the small size of the stock (1 878) precludes the development of any viable commercial fishery. The 1988 test fishery which harvested 29% of the fall run is presumed to have had a significant impact on the stock. When recovered to at least 2 000 fish, a TAC of 5% of the stock (100 fish) may be sustainable.

Management recommendations

1. The Kagluk River charr population should be allowed to recover from the heavy 1988 harvest for another three years (1991, 1992, 1993) before any fishing takes place. The targeted opening for any type of fishery should be 1994.
2. The following are the recommended TACs based on low, medium and high risk levels:
   - i) Low Risk TAC - 0 (no harvest)
   - ii) Medium Risk TAC - 100 fish (5% exploitation)
   - iii) High Risk TAC - 200 fish (10% exploitation)

   On an experimental basis, the TAC could be doubled if fished only every second year.
3. Tag returns from the summer and fall domestic harvests by the community of Holman should be aggressively pursued for information on stock mixing in the summer feeding areas.
4. Should the community of Holman decide to exploit the Kagluk River charr stock at one of the recommended levels, the harvest will have to be monitored on a regular basis. Data to be collected from the harvests should include CPUE data, and biological data for the determination of population characteristics including; mean length and age, length-frequency distribution, catch curve and mortality rate. The weir would likely be used for the domestic harvest, therefore, it would be possible to collect an unbiased sample of the population. Information could be collected in cooperation with native users.

Research requirements

1. Samples of spawners form the Kagluk River stock should be examined for information on maturity and fecundity. Spawners should also be subjected to genetic and morphometric analyses to determine stock identity. Such a sampling program should be carried out in conjunction with sampling of the other three charr streams in Prince Albert Sound. Sea run charr should also be taken at the same time so that a complete assessment of stock identity can be done.
2. If the pattern of exploitation develops in which a fishery takes place every second year, an investigation of the effects on the stock of doubling the TAC and fishing alternate years should be carried out.

Next AFSAC review

February 1994.

ARCTIC CHARR - RAT RIVER

Introduction

The Rat River, located 90 km southeast of Inuvik, NWT, flows east from its headwaters in the Richardson Mountains and drains into the Peel River between Fort McPherson and Aklavik (See Fig. 1). Anadromous Arctic charr of the western form inhabit the river. The charr descend the Mackenzie River to the Beaufort Sea for their summer feeding. During their return migration they are exploited by the Inuit of Aklavik as they pass the settlement, and then by the Dene fishermen of Fort McPherson as they move further upstream.

Background

Stock definition: Arctic charr in the Rat River consist of an anadromous form, and a small, dark-coloured stream resident form. Genetic studies indicate that samples of anadromous spawners from the Rat River were genetically distinct from anadromous spawners taken at the adjacent Big Fish River. Therefore, the Rat River stock is considered to be discrete from the other North Slope charr stocks.

Stock size: In 1989, the upstream migrating stock was estimated at 11 550 fish by a mark recapture technique.

Vital parameters: In 1989, the length-frequency distribution (N = 1 112) was bimodal with the principle mode at 300-350 mm and the second mode at 400-450 mm. Mean length was 414 mm. The lengths ranged from 210 to 610 mm. Ages ranged from 3 to 12 years, with a mean of 6.8 and a mode of 7 years. Age at first maturity was 6 years for the majority of both males and females. By age 8 years, 95% males and 67% females were mature. Female to male ratio from the domestic harvest (N = 504) was 3.3 to 1. For the current year spawners sampled from the run (N = 244), the ratio was 6.2 to 1. Instantaneous total mortality (Z) calculated for ages 7-12 years was 0.87.

Current harvest: Historical harvests indicate heavy fishing with approximately 6 500 charr taken from the Rat in 1972, 2 600 in 1973 and 2 100 in 1975. Interviews of fishermen conducted by staff from the Department of Fisheries and Oceans in 1983 indicated 500 charr were taken that year, 400 in 1984 and 200 in 1985. A census of domestic/commercial fishermen in 1986 indicated approximately 1 050 Arctic charr, believed to be from the Rat River stock, were taken. The 1988 domestic harvest study indicated a catch of approximately 2 100 charr by the communities of Fort McPherson and Aklavik combined. Harvest levels for the 1989 field season are believed to have been similar to those of 1988.

Other impacts: Arctic charr remain very close to shore while feeding at sea. Widespread disturbances such as oil spills which could affect nearshore habitats and could adversely affect Arctic charr stocks along the Beaufort Sea coast. Obstructions (stream crossings, causeways) which hinder migrations could also adversely affect Arctic charr in this area.

Major issues

The migrating stock is vulnerable to fishing by residents of both Aklavik and Fort McPherson. If the stock cannot sustain fishing pressure, then joint agreements will have to be sought for both these communities.

Assessment

Stock prognosis: Based on information from the 1989 Rat River charr investigation, it has been estimated that this population is being exploited at the 18% level. This far exceeds the high risk TAC for this stock. If the present level of exploitation is maintained, catches in the domestic fishery will likely continue to decline as they appear to have done in the past. Information on the recovery of the Big Fish River and a research project on the Babbage River should provide data on exploitation and recovery of the western form of charr.

Management recommendations

1. Since the Rat River Arctic charr stock is suspected of being overexploited, no commercial fishing should be allowed until the population has recovered.
2. The following are the levels of total allowable catches (TAC) depending on the degree of risk taken in the management recommendations.
   i) Low Risk TAC - 0 (no harvest)
   ii) Medium Risk TAC - 575 fish (5% exploitation)
   iii) High Risk TAC - 1 150 fish (10% exploitation)
3. Discussions should be initiated between the communities of Aklavik and Fort McPherson to determine how the domestic harvest should be allocated.
4. Continued monitoring of the population will be required to determine how effective management practices are. The domestic fishery should be monitored on an annual basis with catch per unit effort and biological data collected.

Research requirements

1. Detailed studies of the population dynamics of western Arctic charr should be conducted to determine sustainable exploitation rates.
2. The harvest of Arctic charr from the Rat River should be monitored on an annual basis. This should include harvests from both Fort McPherson and Aklavik. Effort should be estimated and biological samples collected in a non-biased fashion. Evaluation of this data should be the basis of annual management decisions.
3. A tag recovery program from the 1990 domestic fishery should be aggressively pursued. Such recoveries will not only provide biological information but will also help determine the proportion of Rat River charr which are harvested along with Big Fish River fish by the residents of Aklavik at locations other than in the Big Fish River itself.
4. Recovery of the Big Fish River charr population should be carefully monitored. Information obtained should be used in assessing the potential for the recovery of the Rat River population.
5. The mark recapture experiment should be repeated in five years to determine how the population is recovering.

Next AFSAC review

February 1992.

AN OVERVIEW OF THE COMMERCIAL FISHERIES FOR ANADROMOUS ARCTIC CHARR IN THE KEEWATIN REGION, NORTHWEST TERRITORIES

Introduction

Commercial fishing for anadromous Arctic charr has been ongoing in the Keewatin Region since 1960. The mean annual harvest over 30 years has been 32 000 kg. The 1989 commercial harvest was 44 900 kg and the trend is toward an increase in commercial development. The Department of Fisheries and Oceans began monitoring the fisheries in 1972, but there is a paucity of information on stock structure along the Keewatin coast. This, coupled with the existence of significant, but poorly understood subsistence fisheries near all coastal communities, makes effective management of the fisheries very difficult. The AFSAC Fish Subcommittee notes that, despite the fact that the commercial fisheries for charr in the Keewatin are second only to the Cambridge Bay fisheries in economic importance, relatively little research effort has occurred in this area. The quota recommendations given in Table 1 under the heading Region V - Keewatin, are endorsed. A number of other recommendations are made with respect to the Keewatin commercial Arctic charr fisheries as follows.

Management recommendations

1. The quota recommendations given in Table 3 (Region V - Keewatin) are endorsed.

2. New commercial fisheries: The AFSAC Fish Subcommittee endorses the current Fisheries and Habitat Management policy that all new commercial fisheries are to be preceded by a minimum of five years exploratory fishing on that stock, during which the Department of Fisheries and Oceans will be supplied with biological samples from each year's exploratory harvest.

Research requirements

1. Enumeration of the upstream run of charr in Diana River should be conducted to determine whether the stock has recovered and whether such recovery is sufficient to support renewed commercial fishing.

2. Stock identification programs should be initiated for the charr populations along the Keewatin coast.

3. Research on the population dynamics of the eastern form of charr should be continued. Such research should include as an integral part, the investigation of geographic variation in population dynamics in charr. This information will allow the determination of differences in exploitation rates that charr from different areas may be able to sustain.

Next AFSAC review

The charr stock in the Diana River should be reviewed again in February, 1991.

QUOTA RECOMMENDATIONS FOR COMMERCIAL FISHERIES OF ANADROMOUS ARCTIC CHARR, NORTHWEST TERRITORIES - 1990/91

Management recommendations

1. The quota recommendations given in Table 3 are endorsed.

2. The AFSAC Fish Subcommittee endorses the current Fisheries and Habitat Management policy that no new commercial fisheries are to be developed on stocks that currently support subsistence fisheries.

3. It is recommended that fisheries management staff make further efforts to formalize the process of determination of quotas for anadromous Arctic charr stocks. This process was begun with the first report of the Arctic Fisheries Scientific Advisory Committee (Clarke et al. 1989) and could be usefully extended with the production of a background document for AFSAC in 1992. Such a description of the management process should include alternative management strategies depending on factors such as size and importance of the fishery, range of historical data base and completeness of data base. Limitations of existing data bases which restrict management options, as well as methods by which such limitations may be overcome could also be discussed. This formalized process, once completed, could be disseminated to relevant parties, including resources users, local natural resource organizations, area staff, joint management boards, and other government staff, including economic development personnel.

4. A modelling approach should be applied to specific fisheries for which substantial and comprehensive historical data bases exist. These models could use applied yield models such as the Beverton-Holt model. This approach could be refined on an annual basis and extended to other fisheries insofar as the data bases and theory permit. Modelling could usefully start with the Cambridge Bay fisheries (specifically the Jayco River) for which sufficient data exists. A report for 1991 on the applications of yield models to the Jayco River stock should be prepared for AFSAC.

Research requirements

1. Efforts to conduct stock genetics research using morphological and biochemical genetic characters on anadromous Arctic charr stocks should be continued. Such studies are presently ongoing for Mackenzie River stocks and Keewatin stocks, and should be extended to Igloolik area stocks and Cambridge Bay area stocks as resources permit.

Next AFSAC reviews

1. Quota recommendations for 1991 commercial fisheries should be reviewed in February, 1991.

2. Specific stock reports on the Diana River stock and the Iqaluit River stock should be prepared for February, 1991.

3. A report on the Jayco River stock, including the application of yield models, should be prepared for February, 1991.

4. A comprehensive report on Nettilling Lake, including studies enumerating upstream runs of anadromous fish, enumeration of non-anadromous charr and the biological relationship of these two forms with each other, should be prepared for February, 1991.

MACKENZIE DELTA COREGONID FISHERY

Introduction

In 1989 a test fishery for whitefish (both broad and lake whitefish) was proposed for the Mackenzie Delta. At that time (June 1989), the Fish Subcommittee of AFSAC met to review a number of questions related to this proposed fishery, including quota, area for fishing, timing of fishery, mesh size and collection of biological data. The major species, the broad whitefish (Coregonus nasus) had been reviewed by the Subcommittee a few months earlier (Cosens et al. 1990), as part of the 1988/89 scheduled review. The exploratory fishery proceeded in the summer of 1989 with a quota of 16 000 kg which received the endorsement of the Subcommittee.

In June, 1990, AFSAC was asked to consider a further set of questions, this time related to an expanded exploratory fishery being requested for the summer of 1990 in the same area. Members of the AFSAC Fish Subcommittee met on June 27, 1990 to review the questions on the test fishery and developed responses which are included in this report.

Management recommendations

The Fish Subcommittee provided commentary and recommendations in response to the following series of questions:

1. The acceptability of the present commercial quota of 34 000 kg composed of 22 000 kg whitefish, plus 12 000 kg northern pike and inconnu based upon present understanding of Mackenzie River stocks and given the estimated domestic harvest of 65 - 80 000 kg from five closely linked Delta communities.

AFSAC Response

There is no information available which would allow a recommendation to increase the 1989 exploratory fishery quota from 16 000 kg combined broad and lake whitefish (actually a 50/50 ratio of broad to lake means an 8 000 kg quota for broad whitefish) to a 22 000 kg quota for broad whitefish. A conservative exploratory fishery quota (16 000 kg) was made with the recognition that there was a potential for this exploratory fishery to have an impact on domestic fisheries in communities upstream of the Mackenzie Delta (i.e. Arctic Red River, Fort McPherson), due to the migratory nature of the stocks involved. Together with that quota, the 1989 Fish Subcommittee recommendations included the collection of biological data from the 1989 fishery, the setting of experimental gillnets, with recording and analysis of data from fish collected, and recording and analyses of data from samples of each species from the exploratory catch. In addition, it was recommended that there should be upstream monitoring subsequent to the fishery, of broad whitefish on spawning grounds in the Arctic Red River. As no further biological data from 1989 was made available to the Subcommittee at the time of its review in June, 1990, there was considered no basis to recommend any increase in quota over the previous year for whitefish or any other species (pike, inconnu) to be part of the 1990 exploratory fishery.

Any increase in quota to the 22 000 kg broad whitefish, would only be supported by the Fish Subcommittee if the proponents of the exploratory fishery consult with and gain approval from the communities whose domestic fisheries are at potentially the greatest risk, i.e. Arctic Red River, Fort McPherson, Aklavik and Inuvik. Unfortunately, due to the lack of biological data, the degree of risk to existing domestic fisheries in these communities is considered to be difficult to assess.

2. Commentary on the fishing plan provided by the UDC in which fish would be harvested from six camps between Horseshoe Bend and Bombardier Creek beginning on September 3 and ending on September 20, 1990. Contingency plans included the taking of all fish from the camps downstream of Horseshoe Bend if the trapnets at the Holmes Creek location proved to be ineffective.

AFSAC Response

As the Fish Subcommittee did not have access to the complete fishing plan and was only provided with limited scenarios, a general recommendation on the plan was not put forward. It was recommended that the fishing plan to be followed should impose the least risk to broad whitefish and have the fishing effort spread out both space and time. This strategy would minimize fishing pressure on one or a small number of genetically distinct stocks, which could be concentrated geographically at a particular time and, therefore, vulnerable to a fishery which is likewise concentrated. The Fish Subcommittee recommended that any exploratory fishery should take place in two general locations (Holmes Creek area and Horseshoe Bend area), and that fishing effort and hopefully, catch should be relatively equally split between the two areas. If larger quotas are to be approved, the fishery should be over a longer period of time taking into account the previous AFSAC recommendations of a three-week period for the 1989 exploratory fishery of 16 000 kg.

3. AFSAC was queried on the long-term implications of a selective fishery; one in which the use of trapnets would permit selection and retention of broad whitefish, pike and inconnu, while at the same time would allow the escape of lake whitefish.

AFSAC Response

The Fish Subcommittee recommended that, due to differences in size selectivity when fishing with large mesh gillnets versus trapnets, a minimum size limit should be specified for any exploratory fishery where trapnets are to be used as the method to capture fish.

4. Commentary on the sampling program summarized in the VDC proposal and originally recommended by J. Reist, DFO, Science, Central and Arctic Region, was also requested.

AFSAC Response

The Fish Subcommittee endorsed the biological sampling program as first described in the 1989 response by the Subcommittee to the exploratory fishery proposal made that year. That plan calls for biological and genetic samples to be taken at widely varying locations over a reasonable period of time. At a minimum, two different areas in the Delta (e.g. Holmes Creek area and Horseshoe Bend area) should be sampled at least three times during the duration of the fishery. The sampling from locations close to one another (e.g. sites within the Horseshoe Bend area) would not provide adequate information on the spatial heterogeneity of broad whitefish stocks in the Mackenzie Delta. A proposed biological monitoring by the Area office of DFO of broad whitefish stocks at the Peel and Arctic Red Rivers was endorsed by the Subcommittee. This type of monitoring is considered essential for providing the needed information on the status of stocks and enabling the assessment of risks if commercial fishing continues in the Delta.

Next AFSAC Review

This fishery could be reviewed again by AFSAC when sufficient biological data has been analyzed from the exploratory fishery.

REPORT OF THE AFSAC FISH SUBCOMMITTEE: 1990/91

INTRODUCTION

The 1990/91 meeting of the AFSAC Fish Subcommittee was held on February 22, 1991 in Winnipeg. Membership of the Fish Subcommittee in 1990/91 consisted of the following:

D. Bodaly	(Science, Central and Arctic Region), chairperson
R. Crawford	(Science, Central and Arctic Region)
J. Flannagan	(Science, Central and Arctic Region)
A. Kristofferson	(P&FF, Central and Arctic Region)
R. Morin	(Science, Quebec Region)
J. Reist	(Science, Central and Arctic Region).

At that meeting, the Subcommittee considered the following background reports:

- Stock Status of Arctic Charr in the Naloagyok River, Northwest Territories. P. Lemieux (AFSAC Document 90/91-03);
- Stock Status of Arctic Charr in the Kagloryuak River, Northwest Territories. P. Lemieux (AFSAC Document 90/91-04);
- On the Davis Strait/Cumberland Sound Greenland Halibut (*Reinhardtius hippoglossoides* Walbaum): Its Biology and It Fisheries. R. Crawford (AFSAC Document 90/91-02;
- Arctic Charr of the Sylvia Grinnel River. D. Pike and L. Dahlke (AFSAC Document 90/91-05);
- Quota Recommendations for Commercial Fisheries of Anadromous Arctic Charr Northwest Territories 1991/92. G. Low, D. Pike, A. Kristofferson, P. Lemieux (AFSAC Document 90/91-06);
- Commercial Fishing Potential for Sea run Arctic Charr, Koukdjuak River and Nettilling Lake, Northwest Territories. A.H. Kristofferson, R.D. Sopuck and D.K. McGowan (AFSAC Document 90/91-08.

GENERAL COMMENTS

The Subcommittee in its report as the result of its reviews in 1990/91 has followed a more varied format for various stocks according to the recommendations in the Subcommittee report of the previous year (See Appendix 5). As well, the Subcommittee drafted a report summarizing theoretical and practical basis for management of Arctic charr stocks in the Canadian Arctic. This report amalgamates, extends and adds support to the recommendations for research pertinent to all background documents concerning Arctic charr considered by the Fish Subcommittee in 1990/91. Recommendations are put forward on the need for research in the areas of population regulation mechanisms, migration dynamics and warning signs of overexploitation which, if followed, will greatly improve the knowledge base of this Arctic species and permit better management of the resource. This report is included as one of the following sections.

The Subcommittee thanks all those involved in the preparation of the background reports for their untiring efforts. It recommends, and urges strongly, that these documents be prepared for publication in the Canadian Fisheries and Aquatic Sciences Technical Report series, or other suitable publications, if and when appropriate.

GREENLAND HALIBUT (Reinhardtius hippoglossoides Walbaum) OF DAVIS STRAIT/CUMBERLAND SOUND: ITS BIOLOGY AND ITS FISHERIES

Author's abstract

This report provides an overview of the biology of Greenland halibut *Reinhardtius hippoglossoides* (Walbaum) in North Atlantic waters and relates this information to the developing fishery in Davis Strait and Cumberland Sound. Greenland halibut is a mesopelagic piscivorous predator that is the object of an international fishery in Davis Strait using bottom trawls, longlines, and gill nets. Since 1987, this species has also supported a winter fishery in Cumberland Sound. Indigenous fishermen, operating from snow machines and sleds, set longlines through ice and fish in depths between 600 -1 200 m. The halibut they catch are predominantly 9-12 years of age. Young halibut inhabit nursery areas on the banks along both sides of Davis Strait. As they approach sexual maturity, which they attain at about age 10-12 years, they seek deeper water. Mature females are larger than males. They spawn in spring, primarily on the Continental slope and in deep basins (650 - 1 000+ m), such as Cumberland Sound. Currents distribute larvae along western Greenland and eastern Baffin Island where they settle in the nursery grounds on the banks. It is postulated that the fish in Cumberland Sound are a component of a larger population inhabiting Davis Strait.

Management recommendations

None. (See 1989/90 Fish Subcommittee report).

Research requirements

1. Studies of the distribution and abundance, and the biological and physical determining factors of the Greenland halibut in the Davis Strait/Cumberland Sound area are needed. This should include consultation with Danish researchers on the winter fjord fisheries off western Greenland.
2. Studies should be initiated to evaluate the stock identity question through continued collaboration among Quebec, Newfoundland and Central and Arctic Regions' scientists. An initial step towards this goal would be a morphometric analysis of the Cumberland Sound halibut.
3. Fishery management strategies should be developed by Central and Arctic Region in collaboration with Quebec and Newfoundland Regions' scientists.
4. A test of the population scenario proposed by the AFSAC background document should be carried out using experimental fishing gear (e.g. longlines with small hooks of various sizes) in different areas and depths of Cumberland Sound to examine seasonal size structure and distribution of halibut.
5. A stock status report for halibut in Cumberland Sound is due during 1991/1992. Pending the results of this report, a review should be made of the data acquisition procedures for halibut in this region.

Next AFSAC Review

No recommendation.

QUOTA RECOMMENDATIONS FOR COMMERCIAL FISHERIES OF ANADROMOUS ARCTIC CHARR, NORTHWEST TERRITORIES - 1991/92

Summary

Information updates and proposed quotas for 1991/92 are given for the commercial fisheries for NWT anadromous charr. Quota recommendations as indicated in Table 3 are endorsed, however, it is noted that most are based upon little or no information and thus such fisheries represent experiments in management. Current management practices and the biological assumptions that form the basis for management are reviewed. It is recommended that research be initiated to test the assumptions upon which the management decisions are based.

Management recommendations

1. Region I - Mackenzie Delta

   12. Mackenzie River

   There should be no commercial harvesting for 1991/92 and a low subsistence harvest of 600 (5% of estimated run) charr only should be taken. It is recommended that dissociation of the two rivers, Rat and Big Fish, should occur for management purposes and the two be reported separately. Recent research has indicated that the charr in these rivers are not Arctic charr, *Salvelinus alpinus*, but rather most likely Dolly Varden charr, *Salvelinus malma* (J. Reist, Freshwater Institute, personal communication). Significant differences in biological parameters exist between the two forms. For example, Dolly Varden charr tend to mature earlier and grow faster than Arctic charr. Management activities should take these differences into account.

2. Region IV - Central Arctic

   Cambridge Bay area fisheries - 9. Ekalluk R., 10. Ellice R., 11. Halovik R., 14. Jayco R., 22. Lauchlan R., 27. Paliryuak R., 29. Perry R.

   Recommendations for specific quota decreases and increases are accepted as enumerated in Table 3. Substantive management effort and research activity are necessary to; a) document further warnings of potential over-exploitation of some stocks; b) discern causation for the decline in mean length, mean age, and length distribution observed in two of these stocks; and, c) ascertain the effects of increased quotas for the affected stocks.

3. All other quota recommendations are accepted as detailed in Table 3.

4. The Fish Subcommittee of AFSAC recognizes the importance of this report for annual quota recommendations, but notes that this is for only commercial harvested anadromous charr stocks. Similar reports for commercial freshwater and anadromous stocks of all relevant Arctic species are warranted. As marine commercial fisheries are initiated, a similar format should be implemented for those as well.

COMMERCIAL FISHING POTENTIAL FOR SEARUN ARCTIC CHARR, KOUKDJUAK RIVER AND NETTILLING LAKE, NORTHWEST TERRITORIES

Author's abstract

The commercial fishing potential for searun (anadromous) Arctic charr of the Koukdjuak River and Nettilling Lake (See Figure 1) was evaluated, based on fishing history and biological data gathered during 1974-77. Fishing in Nettilling Lake proper resulted in harvesting heavily parasitized non-anadromous charr of questionable commercial value. Searun charr of excellent quality were harvested during the upstream migration in the Koukdjuak River on the fishing grounds near Nikku Island. Gillnets proved successful in harvesting approximately 22 000 kg of charr annually over the four year period. An apparent failure of the 1976 fishery was attributed to harsh environmental conditions which resulted in poor condition of the fish and an early upstream migration, some of which was missed by the fishermen. A Schaefer mark-recapture estimate of the number of charr in the 1976 upstream migration suggests a run of approximately 182 000 anadromous charr of 40 cm or more in length. Koukdjuak River charr are relatively slow growing. This combined with the performance of the 1974-77 fishery suggests a conservative annual exploitation rate of 6.5% for charr 40 cm or longer in this stock. Thus, a safe harvest level (SHL) of 22 000 kg, round weight, is recommended for the anadromous charr stock of the Koukdjuak River and Nettilling Lake.

Management recommendations

1. An annual safe harvest level (SHL) of 22 000 kg, round weight, is recommended for anadromous Arctic charr of the Koukdjuak River/Nettilling Lake system. This SHL is based on a minimum population estimate, and as such should not be detrimental to the stock. Future research may in fact reveal that a higher level of exploitation (optimum sustainable yield) is sustainable by the population.

2. Fishing using gillnets, (139 mm minimum mesh size stretched measure) in the vicinity of Nikku Island is the recommended method of harvest. Fishermen should avoid fishing in Nettilling Lake proper to minimize the incidence of heavily parasitized non-anadromous charr in the catch.

3. It is recommended that fishermen be on site no later than August 15 in the event that the upstream run of anadromous charr is early. Initial effort should be limited to 200 - 300 m of gillnet daily until a consistent increase in catch-per-unit-effort indicates the arrival of the run on the fishing grounds.

4. If commercial fishing for searun Arctic charr takes place in the Koukdjuak River in future, the catch should be sampled annually to establish a biological data base to which yield models can be applied in order to determine an optimum sustainable yield.

Research requirements

None identified.

ARCTIC CHARR - KAGLORYUAK RIVER, PRINCE ALBERT SOUND

Background

Stock definition: The anadromous stock is assumed to be a discrete stock. A small sample (n=20) was collected in 1990 to confirm this by genetic and morphometric analyses, although this sample was probably inadequate to provide reliable measures of genetic and morphological characteristics. About one in twelve of the fish caught had fresh or old gillnet marks, assumed to be from the Safety Channel fishery, 200 km away. Fish from two other rivers in Prince Albert Sound tagged in 1988 and 1989 suggest that about 4% wandering occurs among these rivers. The spawning part of the Kagloryuak population was not investigated.

Stock size: The upstream migration of anadromous charr was monitored, using a weir, from August 11 to September 5, 1990. It appears that most or all of the migrating fish were enumerated. The count for upstream migrating fish was 13 072. These plus the spawning population are assumed to comprise the total population of anadromous charr in the river system.

Vital parameters: Based on a sample of 489 charr passing through the trap set up on the river in 1990 the following parameters were obtained:

Modal fork length (range):	400-450 mm (298-766)
Mean fork length:	479 mm
Mean age:	9.9 years
Modal age (range):	9 years (4-15)
Sex ratio F:M:	1.30
Age at 1st maturity both sexes):	8 years

At age 8, 50% males and 17% females were mature, by age 11 all fish were mature.

Current harvest: Using the following series of assumptions and estimations, the current harvest was estimated at 6% of the population:

1. 3-5 000 fish are taken annually, mostly from the Safety Channel area.

2. This catch is assumed to have come equally from the rivers of Prince Albert Sound and Minto Inlet, because it is equidistant from both areas.

3. The total number of fish available to the fishery from the Sound area is assumed to be the total number of fish counted (in different years on different rivers) in the four rivers in the Sound, plus the summer fishery harvest (46 000 + 3 000 = 49 000).

4. The Prince Albert Sound part of the summer fishery is estimated at 3 000 fish. The Safety Channel exploitation rate of Prince Albert Sound fish is then calculated to be 6% (3 000 ÷ 49 000 x 100).

5. From #2. above, the exploitation of Kagloryuak R. is then assumed to be 6% of the population.

It should be noted that, depending on how these figures are used, a wide range of exploitation ranges could be calculated.

Other impacts: No other serious impacts were identified.

Major issues

No major issues were identified.

Assessment

Stock prognosis: It is assumed that the net mark rate of 8.4% indicates that significant numbers of charr from this system are being harvested in other areas. It is suggested that this exploitation may be 6% of the population. Fishery managers believe that exploitation rates between 5 and 10% of charr greater than 400 mm in length are sustainable by the eastern form of Arctic charr. If the exploitation rates calculated here are reasonably accurate, then little additional commercial exploitation is acceptable. If the human population and/or the demands of the domestic fishery of the area increase, the prospect of a viable commercial fishery becomes even less promising.

Management recommendations

1. The river population should only be fished commercially on a biannual basis. The total allowable catch (TAC) should be set at 5% of the total population, i.e. a total of 650 fish or a round weight of 850 kg to be taken only every two years.

2. Tag returns from the Holman community summer and fall domestic harvest should be aggressively pursued since a large number of charr have been tagged from four different charr streams in the Sound. These tag returns may provide information on the reliability of the 6% exploitation rate estimated for the domestic fishery.

3. The Kuujjua River population should be assessed in 1991 and a part of the population tagged. This will complete the requirements for the formulation of a management plan for Holman. Tag returns from this population in the 1992 domestic fishery will provide information on the relative contributions of Minto Inlet and Prince Albert Sound charr to the domestic fishery.

Research requirements

1. Simultaneous samples of spawners and sea run charr from the four rivers in the Sound, as well as the six Minto Inlet rivers (Kuujjua) should be analysed to provide information on maturity and fecundity. A sufficiently large sample to allow reliable genetic and morphometric analyses for stock identification purposes should be taken. This program, in conjunction with information from tag returns, should allow a more reliable assessment of the stock.

Next AFSAC review

No recommendation.

ARCTIC CHARR - SYLVIA GRINNELL RIVER

Synoptic Abstract (author's abstract missing):

Between 1958-1966, the commercial Arctic charr of the Sylvia Grinnel River (near Iqaluit, Baffin Island) fishery produced a mean annual harvest of 5 502 kg (range 3 824 - 9 803 kg), with an additional annual subsistence harvest estimated to be 12 000 kg. The commercial fishery collapsed in 1967 and had not recovered by 1977. Recreational and subsistence fishing had continued during this period and beyond. In 1986, the stock was re-examined. Experimental gill nets were fished in one location on 26-30 August. The subsistence fishery was also monitored (7 July - 30 August) and a sport fishery creel census was conducted from 4 July - 30 August. Data were compared with the results of similar 1976-77 surveys. Fish caught by experimental gill nets were smaller in 1986, but fish caught in the domestic fishery were larger and older. Mortality was lower (survival increased) in experimental catches in 1986, and there was no difference in the mean condition factor attributable to sex. There was no significant difference between von-Bertalanffy growth curves derived from experimental fishing data in 1976/77 and 1986 (although growth was slow for both). Mean catch rates within the recreational fisheries for these two periods were also similar. Within the domestic fishery, mean fish weight was higher in 1986, while the number of fish caught was similar. Catch rate was lower in 1986, but nets were fished during a much longer period of time. The authors observed that the experimental gill net data may not be representative due to brief sampling periods. They concluded that domestic catches indicated that some stock recovery has occurred between 1977 and 1986, but truncated size- and age-frequency distributions in the latter data indicated recovery was incomplete.

Management recommendations

1. A communication/education package should be prepared on the biology and stock status of Sylvia Grinnell charr. A communication package on the harmful effects of small mesh gill nets on the charr population should be undertaken only if there is objective evidence that the use of such small meshes is harmful to

populations of Arctic charr. Untested dogma regarding exploitation by small mesh nets should be avoided.

2. Public meetings should be held to gain input into a management plan for the river.

3. A monitoring/stock assessment study should be carried out in 1991. Objectives of this study should include: Monitoring of harvests and catch per unit of effort of domestic and sports fisheries, and assessment of stock size and stock health. User groups should be involved in the study to the maximum extent possible. Science should be requested to provide input during the design phase and execution of this study.

4. It is a locally popular notion among resource users of the Sylvia Grinnell River, that pollution from the Iqaluit garbage dump has affected the recovery of the charr stock more than unsuccessful fishery management has. Future management efforts would benefit from an improved public perception of Departmental responsiveness to user's concerns. Toward this end, a scientific evaluation of this perceived problem in recommended.

Research requirements

None identified.

Next review by AFSAC

Results of the 1991 monitoring/assessment study should be prepared for AFSAC review in 1991-92. In this report, the evaluation of stock recovery by the examination of recent data (from 1986 monitoring, and when available, from 1991 monitoring) would be enhanced by comparisons with data from 1951. The 1986 modal length was similar to that in 1951, suggesting that some recovery of the stock has taken place.

ARCTIC CHARR - NALOAGYOK RIVER

Background

The Naloagyok River drains into the southeast end of Prince Albert Sound. Previous exploratory fisheries by DFO in 1985 identified a run of anadromous Arctic charr in this system. Residents of Holman, approximately 210 km to the northwest, are interested in expanding a small commercial fishery which takes place near the community. Proximate stocks are currently heavily exploited by a subsistence fishery. DFO advised residents to consider more distant locations, such as the Naloagyok River, for commercial fishing. The Fisheries Joint Management Committee (FJMC) funded a study to assess the commercial potential of this river in 1989. The assessment was accomplished by counting the upstream migrants through a fish weir. Results are presented here.

Stock definition: Tag returns to date suggest that the Arctic charr of the Naloagyok River comprise a discrete stock. Enzyme analysis is underway to provide further evidence, but sample sizes were limited.

Stock size: The weir was operational from 22 August to 7 September during which time a total of 22 386 upstream migrating charr were counted.

Vital parameters: Two size modes were evident, the first of 350 - 400 mm and the second of 500 - 550 mm. Mean for length was 454 mm (N = 755) and range was 315 - 742 mm. Age distribution was bimodal at 9 and 11 years with mean 9.5 years (N = 101) and range 4 - 19 years. Mean round weight was 1.35 kg (N = 105) and condition factor (K) was 1.09.

Estimated age at first maturity was 10 years for males and 6 years for females. The sex ratio of females to males was nearly even (1.11:1.0).

Instantaneous total mortality (Z) calculated for ages 12 - 14 years was 0.46 (r = 0.99).

Current harvest: Historically, Inuit harvested charr at this site for subsistence use as evidenced by the presence of stone fish caches and tend rings. This location has not been exploited in recent years because ice flows create travel problems in Prince Albert Sound in summer. However, the presence of net marks on some of the upstream migrants suggests that this stock is exploited to some degree by the summer fishery in the Safety Channel area, 180 km to the northwest. Exploitation rate may be in the order of 6% annually, but future tag returns should provide a better estimate of exploitation.

Other impacts: No serious impacts are identified at this time.

Major issues

No major issues are apparent at this time.

Assessment

Stock prognosis: In comparison to some other charr runs (Ekalluk River - 183 000 charr) this stock (22 000) does not appear to be large. Experience has shown that annual exploitation of 5 - 10% of charr >400 mm in the run should be sustainable. A rough estimate of current exploitation is in the order of 6%. A total annual harvest rate of 7.5% would include about 1 600 charr, of which perhaps 1 300 are already being taken. Therefore, it is concluded that additional exploitation of this stock should be limited until more definite information on current exploitation rate is made available. Thus, at this time, it appears that the commercial potential at Naloagyok River is limited.

Management recommendations

1. A total Allowable Catch (TAC) for the Naloagyok River Arctic charr stock should not exceed 1 600 charr or 2 200 kg annually. Given the current exploitation, a safe harvest level (SHL) for a fishery executed at the Naloagyok River itself should not exceed 300 charr or 400 kg annually until accurate data on current exploitation becomes available. Biannually,

this would represent an on-site harvest of 600 charr or 800 kg.

2. The Naloagyok River charr stock is one of four (others include the Kuuk, Kagluk and Kagloryuak) charr stocks utilizing Prince Albert Sound that has been assessed recently with a counting weir. Many charr have been tagged during these assessments but returns to date have been poor. The high incidence of net marks on upstream migrants indicates exploitation is taking place to a greater extent than the tag returns suggest. Fishermen from Holman should be encouraged to return all tags taken in order that reliable estimates of current exploitation can be made. TACs can then be adjusted accordingly.

3. The charr stock of the Kuujjua River near Holman should be assessed in 1991. A fishery management plan for the community of Holman can then be developed which would include the stocks in Prince Albert Sound.

Research requirements

1. Stock identity of Naloagyok River charr should be determined with genetic and morphological analyses of spawners. Data on maturity and fecundity could be gathered coincident with this study.

2. The close proximity of the Kuuk, Kagluk, Naloagyok and Kagloryuak rivers provides an unique research opportunity to conduct simultaneous studies on these charr stocks to investigate stock structure and interchange of non-spawners between systems. The feasibility of such a study should be considered.

Next AFSAC review

February 1992.

RECOMMENDATIONS FOR FUTURE CHARR RESEARCH IN THE CANADIAN ARCTIC

This report by the Fish Subcommittee of AFSAC presents a generalized discussion of the theoretical and practical bases for the management of exploited populations of charr in the Canadian Arctic. It makes recommendations for research based on the need to improve scientific understanding of subjects such as population regulation mechanisms, the dynamics of migrations, and the use of overexploitation warning signs which will improve the knowledge base upon which practical management is based. The report amalgamates, extends, and adds to recommendations for research pertinent to all background documents concerning Arctic charr considered by the Fish Subcommittee of AFSAC in 1990-91.

Two species of charr exist in the Canadian Arctic. Dolly Varden charr, Salvelinus malma, occupy riverine habitats on the continental north slope west of the Mackenzie River. Arctic charr, Salvelinus alpinus, occupy lacustrine habitats to the east. The species differ with respect to biological parameters such as growth, age at maturity, and maximum sizes and ages. The following applies generally to both species but the relative importance of a particular assumption may differ between species.

The several assumptions are either explicit or implicit in the process of management of charr fisheries as outlined in Johnson (1976, 1980, 1989) and Kristofferson et al. in a background document prepared for AFSAC (86/87-10). Research to test the validity of these must be given high priority to ensure proper foundation of management principles.

1. Charr are assumed to form discrete genetic stocks or biological populations on the basis of one stock per freshwater system identified as having an upstream migration in late autumn. There is evidence for this amongst four adjacent Dolly Varden charr stocks along the Yukon north slope (Reist 1989), but the assumption needs to be tested across a broad geographic area.

2. Each such stock is assumed to be able to sustain an annual level of exploitation. Hunter (1976), in 1958 and 1959, examined the Arctic charr in the Sylvia Grinnell River, Baffin Island, after a significant period of exploitation. It was noted that the rate of exploitation for this stock was 9.4% for fish from 14 - 20 years of age, and 24.2% for fish 21 years and older. These rates were considered to be sustainable, although since then this stock has apparently collapsed (see report on Sylvia Grinnel R.). Results of a multi-year research project on a stock of anadromous Arctic charr overwintering in Nauyuk Lake in the central Arctic revealed that an exploitation level of 11% of charr >40 cm in length (9% of the total population, i.e. fish larger than 150 mm in length) was excessive and led to a decline in the population. In the absence of additional research on sustainable levels of exploitation for charr, for management purposes, 10% is now considered an upper limit, at least for the central Arctic, and stocks are managed in order to maintain rates of exploitation at or below this level. The research foundation upon which this management practice is based is small and, therefore, the total exploitation rate that charr populations can optimally sustain is uncertain. Various rates of exploitation require experimental testing over relatively long periods of time to determine long-term sustainability. Furthermore, the degree to which a single rate of exploitation could be applied to and sustained by populations over broad geographic areas is unknown. Research is required to investigate these questions.

3. Given no substantive external perturbations such as exploitation, the size of charr stocks is assumed to be relatively stable from year-to-year. Available evidence is contradictory. No fluctuations which would indicate massive yearly immigration or emigration were observed in the Nauyuk system, but rather a steady decline was noted, much of which could be attributed to an existing subsistence fishery (Johnson 1989). However, counts of upstream migrants into the Diana River were consistent between 1973 and 1974, but almost doubled

between 1974 and 1975, then remained relatively consistent between 1975 and 1976 (Kristofferson et al. 1990). Given that one-time counts of upstream migrations are used as indicators of population size for management purposes, the assumption of stability of the population size (upstream migrants) must be tested.

Related to this, it is generally assumed that the majority of spawners home to natal streams (or that they home to sites where they first spawned and that such initial site choice is constant across generations). Relevant to the use of counting weirs to determine the size of populations, the fidelity of non-spawners to their natal systems is assumed to be high. Available evidence (e.g. the Nauyuk study, data from tag returns described in numerous AFSAC background reports) suggests that this may not always be so. Tagging studies to date have shown that non-spawners overwintering in one system one year have been captured migrating upstream into an adjacent system the next year. Thus, although present results do not suggest massive interchange of fish between systems, any particular upstream migration is probably composed of fish from several discrete stocks and a major unknown is the degree to which homing may vary among systems and over time. Therefore, there is some question regarding the confidence managers can have in population estimates derived from the current practice of enumeration of charr runs by counting fences, in the absence of information on the discreteness of that population or the composition of the run. To improve management strategies, research is required on the amount of and reasons for interchanges of fish between systems. Physical factors such as water levels which can control access may play a major role in such interchanges.

4. It is generally assumed that over large parts of the range of charr, spawners do not go to sea in the summer prior to spawning and that they therefore represent a small portion of the total migratory stock. This assumption stems from work at Nauyuk Lake and counts of upstream migrants in streams and rivers of the central Arctic, Keewatin and Baffin areas. In the western (Yukon) and south-eastern (Labrador) areas there is some evidence that current-year spawners may go to sea, but are the first to return, well in advance of the non-spawning feeders. Due to an iteoparous life history and the energetic consequences of spending two winters and the intervening summer in freshwater as well as spawning, reproductive fish face severe constraints and may experience high mortalities. The generality of spawners remaining in freshwater should be examined, as should the consequences of winter fisheries that may target spawning segments of the population.

5. The food available in the summer probably determines the number of spawners, as well as the frequency of spawning. The latter is also of course determined by mortality of spawners. There is a need for research which could advance the understanding of these interrelated processes.

6. Fisheries, where they occur, are assumed to target only specific, or at most, a few related genetic stocks. Thus harvest data is combined with enumeration data to yield a known exploitation rate for a particular stock. Given the fact that many fisheries operate on the summer feeding marine components of charr stocks, that charr range widely during such life history phases, and that mixing of stocks apparently occurs, it is difficult to apply these management objectives and assumptions to such fisheries. Management of such fisheries on a stock basis would require information from tagging, morphological and/or genetic research which could identify the fish as to their genetic stocks of origin.

7. It has been assumed that reductions in population parameters such as mean and modal age and length and changes in age- and length-frequency distributions will be indicators of excessive exploitation. Practical experience, as well as experimental evidence (e.g. Johnson 1989), have shown that, indeed, charr stocks will ultimately be reduced in size and age as a result of over-exploitation, but not until population number has been significantly reduced. Therefore, these parameters are apparently not particularly sensitive to changes in population size, preventing their use by managers to reduce exploitation levels to prevent a collapse of the fishery. In some cases, catch-per-unit-of-effort (CPUE) data provide a better indication of population decline, but reliable CPUE data, where "runs" of charr are involved; are difficult to obtain. Thus studies are required which will identify true and accurate early warning signs of decline in standing stocks and estimate the generality of such early warning signs.

8. It is generally assumed that for charr, overwintering and spawning habitats are critical and limiting to populations. This is particularly so for Dolly Varden charr which occupy riverine habitats, where overwintering and spawning habitats are synonymous, and only occur at sites of perennial springs of sufficient flow. Territorial defense and optimality criteria presumably constrain fish usage of the habitat, as well as the maximum number of fish present in the habitat. Therefore, the primary regulatory mechanism for the population may be the extent and quality of the overwintering habitat and the ability of the fish to select and maintain an optimal position in that habitat. Overwintering habitat may also be limiting for the Arctic charr, especially if the spatial segregation of non-spawning and spawning components of the population to different overwintering habitats as found by the Nauyuk Lake study is general. The physical and chemical parameters of overwintering habitat, its relationship with spawning habitat, the details of fish usage of such habitat, and the effects of habitat alteration on the populations, are important topics for investigation.

9. Observations on the Nauyuk Lake population of Arctic charr (Johnson 1989), as well as previous research (Johnson 1976, 1980), have

led to the development of a model of population regulation for Arctic fish. This model suggests that the stable equilibrium state for Arctic fish populations is a bimodal size frequency structure in which a standing stock of adults regulates the recruitment of juveniles into the adult stock. The transition from juvenile to adult is accompanied or accomplished by rapid growth. Thus, the most important component of the population is the standing stock of adults and, regardless of their abundance, the juveniles can only be recruited to the adult population when sufficient relaxation of the regulatory mechanism occurs.

Combined with the above assumptions, this model spawns a series of relevant research questions which focus on many of the above assumptions.

a) Is bimodality in size structure the equilibrium state for unexploited and unperturbed Arctic fish populations?
b) Does this model also apply to other 'types' of fish - e.g. freshwater, anadromous, marine, riverine, lacustrine; r and K-selected?
c) How stable and how fragile is this equilibrium state?
d) How does exploitation (or some other perturbation alone or in concert) affect this equilibrium state?
e) How are changes in the equilibrium state manifested and can such changes be tracked using easily measurable parameters?
f) Is the movement from stability catastrophic or is it gradual? Is the new configuration stable?
g) What components in the population and its environment are critical to ensure stability?
h) Once perturbed, can recovery be effected? If so, how?
i) Do current fishery and management practices differentially negatively affect the equilibrium state of charr populations - e.g. what effects do fixed large mesh (139 mm) fisheries have, is pulse fishing more appropriate than sustained exploitation, should fisheries target juvenile components differentially?

The practical management of populations of Arctic charr is based, as is the management of all populations of exploited animals, upon certain critical assumptions. The above lists the most important of these based on current understanding, however, it should not be considered to be exhaustive and other factors may be found to be important in charr population regulation as research advances understanding. It is clear that the accuracy and generality of many of the above listed assumptions would be improved by testing and research to further improve the theoretical base for management practices.

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Table 1. Domestic harvest statistics for belugas and narwhal in various areas of the Arctic.[a]

Area	1988		1989	
	Beluga	Narwhal	Beluga	Narwhal
Western Arctic	116[b]	0	236[bd]	0
High Arctic	125[b]	196[b]	88[b]	286[b]
South Baffin/ Hudson Strait	109[b]	4[b]	137[b]	40[b]
Ungava Bay	0[c]	0[c]	0[c]	0[c]
West Hudson Bay	195[b]	37[b]	203[b]	13[b]
Eastern Hudson Bay	20[b]	0	20[b]	0
Total all areas	577[b]	237[b]	684[b]	339[b]

[a] Source: I.W.C. Reports for Central and Arctic Region, DFO, for 1989, prepared April, 1990, and for 1990, prepared April, 1991.

[b] Quantities are landed harvest with no corrections for lost animals or unreported harvest.

[c] Quantities to be provided by Quebec.

[d] Includes 125 belugas that were trapped in Husky Bay and later harvested by the communities of Inuvik and Tuktoyaktuk.

Table 2. Proposed schedule for AFSAC reviews in FY 1991/92 and 1992/93.

1991/92 PROPOSED SCHEDULE FOR AFSAC REVIEWS

Year/Committee	Species/Stock	Background Report Author(s)	Type of Report	Comments
1991/92 Fish Subcommittee	Arctic charr commercial/ anadromous in NWT	A. Kristofferson	annual	annual harvest data & quota recommendations
	Coregonids: Mackenzie Delta	P. Lemieux	Western Arctic office	increased quotas/new harvest data
	Inconnu: Great Slave L.	R. Moshenko	rescheduled from 1990/91	1st review
	Arctic charr: Ekalluk River	A. Kristofferson/ G. Low	from 1989 AFSAC review	recommended for a 1990 review, but not scheduled
	Paliryuak River	"	"	"
	Halovik River	"	"	"
	Lauchlan River	"	"	"
	Jayco River	"	"	"
	Ellice River	"	"	"
	Perry River	"	"	"
	Lake Whitefish: Great Slave L.		rescheduled from 1989/90	1st review

Table 2. (cont'd)

1991/92 PROPOSED SCHEDULE FOR AFSAC REVIEWS

Year/Committee	Species/Stock	Background Report Author(s)	Type of Report	Comments
1991/92 Fish Subcommittee (cont'd)	Greenland Shark	D. Pike	Area Office Eastern Arctic	1st review
	Arctic Charr: Keewatin Inland Lakes	?	from 1989 AFSAC review	reviewed by AFSAC in 1989
	Broad Whitefish: Lower Mackenzie Basin	?	from 1989 AFSAC review	reviewed by AFSAC in 1988 & 1989
	Arctic cisco: Lower Mackenzie Basin	?	from 1989 AFSAC review	reviewed by AFSAC in 1989
	Arctic charr: Jayco River	?	from 1990 AFSAC review	
	Arctic charr: commercial/ anadromous	A. Kristofferson	annual summary	annual harvest data & quota recommendations
	Arctic charr: Diana R.	?	from 1990 AFSAC review	

Table 2. (cont'd)

1991/92 PROPOSED SCHEDULE FOR AFSAC REVIEWS

Year/Committee	Species/Stock	Background Report Author(s)	Type of Report	Comments
1991/92 Fish Subcommittee (cont'd)	Arctic charr: Pond Inlet	A. Kristofferson	Fish & Hab. Manag.	1st review
	Arctic charr: Big Fish R.	P. Lemieux/ A. Kristofferson	rescheduled from 1989/90	reviewed by AFSAC in 1988
	Arctic charr: Firth R.	P. Lemieux/ A. Kristofferson	rescheduled from 1989/90	reviewed by AFSAC in 1988
	Arctic charr: Rat River	?	from 1990 AFSAC Review	
	Arctic charr: Sylvia Grinnel R.	?	from 1991 AFSAC review	
1991/92 Marine Mammals	Harp Seal	R. Stewart/ M. Kingsley	rescheduled from 1988/89	1st review
	Walrus: Fox Basin	P. Richard/ R. Stewart/ T. Smith	rescheduled from 1989/90	
	Narwhal: High Arctic	P. Richard/ S. Cosens	from 1989 AFSAC review	reviewed by AFSAC in 1987 & 1989

Table 2. (cont'd)

1991/92 PROPOSED SCHEDULE FOR AFSAC REVIEWS

Year/Committee	Species/Stock	Background Report Author(s)	Type of Report	Comments
1991/92 Marine Mammals (cont'd)	Narwhal: Northern Hudson Bay	?	rescheduled from 1990/91	reviewed by AFSAC in 1988
	Beluga: Southeast Baffin	P. Richard/ D. Pike	from 1989 AFSAC review	reviewed by AFSAC in 1987 & 1989

Table 2. (cont'd)

1992/93 PROPOSED SCHEDULE FOR AFSAC REVIEWS

Year/Committee	Species/Stock	Background Report Author(s)	Type of Report	Comments
1992/93 and later				
Fish Subcommittee	Arctic grayling: Kakisa River	?	rescheduled from 1989	1st review
	Walleye: Mosquito Creek	?	from 1988 AFSAC review	reviewed in 1987 & 1988
	Walleye: Tathlina L.	?	from 1987 AFSAC review	reviewed in 1987
	Walleye: Kakisa L.	?	from 1987 AFSAC review	reviewed in 1987
	Arctic charr: Kagluk River	?	from 1990 AFSAC review	
	Lake Whitefish: general	?		scheduling flexible
	Lake Trout: general	?		scheduling flexible
	Arctic charr: Naloagyok R.	?	from 1991 AFSAC review	

Table 3. 1989/90 quotas and harvest, 1990/91 quotas and harvest and 1991/92 recommended quotas for the anadromous Arctic charr commercial fisheries in the Northwest Territories. Regions and numerical designations of water bodies follows that of Schedule V, Northwest Territories Fishery Regulations. Quotas and harvest figures are in kilograms, round weight. Quotas in brackets are equivalent dressed weight. Note: For quotas marked *, round to dressed weight conversion factor is 0.80. This includes an estimate for subsistence take and cullage. For all other quotas, conversion factor is 0.87 because data on subsistence take and cullage are not available for these fisheries. (NF = not fished, NA = not available at present).

Waters	1989/90 Quota/Harvest	1990/91 Quota/Harvest	1991/92 Quota

REGION I - MACKENZIE DELTA

9. Hornaday River	not opened	not opened	nil

Stock was overexploited in past, resulting in closure of the commercial fishery in 1987-1990. Important subsistence fishery continues here. Estimated subsistence harvest is 1 600 - 2 200 charr annually. Catch was sampled in 1989 and 1990 but stock does not appear to have recovered. Recommend no commercial fishery for 1991. Recommend subsistence harvest not exceed 800 charr in 1991. See Fish Subcommittee report for 1989/90 on this stock for details.

12. Mackenzie River	not opened	not opened	nil

Charr from the Big Fish and Rat rivers were taken by this fishery. Due to overexploitation of Big Fish River stock, a ban on all fishing has been in effect since 1987. Plans for 1991 include enumeration of the upstream run to assess current status. No harvest is recommended pending results of the 1991 study. Stock assessment was carried out on upstream run in Rat River in 1989. Run estimated at 11 500 charr. Current subsistence harvest estimated at 2 100 charr annually. This rate of exploitation (18%) may be excessive. Recommend no commercial fishing for 1991 and subsistence harvest be reduced to 600 charr annually to allow stock to recover. See Fish Subcommittee report for 1989/90 on this stock for details.

REGION IV - CENTRAL ARCTIC

1. Agnew River Area	4 500/NA	4 500/NA (3 900)	4 500 (3 900)

Status of this fishery unknown. Winter fishery ongoing at time of this report. No harvest data available. Apparently was not fished in 1989/90 year. This quota not usually fished due to distance from the community of Spence Bay.

2. Arrowsmith River	1 000/NA	1 000/0 (900)	1 000 (900)

Waters	1989/90 Quota/Harvest	1990/91 Quota/Harvest	1991/92 Quota
2. Arrowsmith River (cont'd)			

No commercial harvest by residents of Pelly Bay in winter 1989/90. No harvest data available at time of writing. Subsistence harvest estimate not available but believed to be light. Stock overexploited in past. Recommend nominal commercial quota of 1 000 kg in order to obtain a sample.

3. Becher River	1 000/558	1 000/NA	1 000 (900)

Commercial harvest in 1989/90 was 558 kg. Subsistence harvest data unavailable. Should be sampled in future. Total harvest is not taken because all charr harvested out of one wide part of river. Fishing in overwintering lake is not successful since the charr do not seem to move around.

6. Coppermine River	600/600	600/600 (500)	600 (500)

Past studies indicate this stock was heavily exploited. It is not believed to be in trouble at present, although it still supports a substantial subsistence fishery. Estimated subsistence harvest 8 - 10 000 charr, sport harvest 250 - 300 charr, commercial 200 charr. Commercial sample (N = 58) in 1989 showed mean length = 641 mm, mean age 11 y. No sample taken in 1990. Sample required in 1991. Recommend nominal commercial quota of 600 kg.

7. Curtis River	4 500/180	4 500/NA (3 900)	4 500 (3 900)

This winter fishery is carried out by residents of Repulse Bay. Harvest has been low and sporadic in the past; last year's harvest was 180 kg. Domestic harvest is reported to be <500 kg annually. No current harvest data at time of writing. Sampling carried out in 1986 and 1987 indicated that the stock was lightly exploited. No problems with this fishery.

9. Ekalluk River	14 500/13 565	14 500/15 294	7 500 (6 000)*

This stock is the mainstay of the Cambridge Bay commercial fishery. A decline in the mean length and age of the catch in 1987 and 1988 caused some concern. The status quo was recommended for the 1989 quota because the decline did not appear to be related to overexploitation. Similar declines were noted in samples from other, lesser-exploited stocks utilized by the Cambridge Bay fishery.

9. Ekalluk River (cont'd)

Fishing was reported to be good during 1989, in spite of the fact that the catch fell short of the quota by about 1 000 kg. A sample of the 1989 catch revealed that the mean length of charr increased to 640 mm from 611 mm in 1988 (t-test, $P<0.001$). The length distribution was significantly different between 1988 and 1989 (Chi-square, $P<0.001$). Seventy-three percent of the sample in 1989 was 600 mm in length or larger compared with 58% in 1988. No significant difference in the age composition of the samples was noted between 1988 and 1989. Minimum exploitation rate, calculated from tag returns in 1979 was about 10% compared with 5% from tag returns in 1989. Instantaneous total mortality, calculated for the ages 14 - 20 years, was 0.54 in 1989 compared with 0.80 for ages 15 - 19 years in 1988. The reasons for the decline in size observed in samples from this location in 1987 and 1988 are not readily apparent. However, the increase in size observed in the 1989 sample, the decline in mortality rate in 1989 and the lack of evidence for an increase in exploitation rate in 1989 compared with previous years suggested that this stock was not overexploited at that time. Therefore, it was recommended that the annual quota remain at 14 500 kg. A meeting was held with resource users prior to the 1990 season to discuss the implications of this fishing strategy. They were made aware that adjustments to the harvest level would be necessary if further data indicated a trend toward a decline in the stock. The data from the 1990 sample indicate that, indeed, a trend toward a decline is developing. The 1990 harvest exceeded the quota by 794 kg. Fishing took place from Aug. 16 to Aug. 23, for a total of eight days. Two family groups plus 3 individuals fished this quota apparently with a total of 7 x 91 metre 139 mm mesh gillnets. From the sample ($N = 240$) mean length declined to 621 mm from 645 mm in 1989 (t-test, $P<0.001$). Mean age declined to 12.7 years, from 13.6 years in 1989 (t-test, $P<0.001$). Modal length was 600-650 mm both years, however, only 60% of the sample were 600 mm in length or larger compared with 73% in 1989. Length-frequency distributions differed significantly (Chi-square, $P<0.015$) between years. Modal age dropped to 12 years from 14 years in 1989. To some extent, this could be the influence of a strong year class, noticed as 10 year old charr in 1988. Only 35% of the sample was aged 14 years or older in 1990 compared with 54% in 1989. Age-frequency distributions differed significantly (Chi-square, $P<0.005$) between years. Instantaneous total mortality for ages 15-18 years was 0.65 compared with 0.54 for ages 15-21 in 1989. Although fishermen did not notice any apparent decline in CPUE in 1990, this may not be surprising because a 'run' of fish is involved. Tag returns from earlier studies suggest that the majority of charr taken by the spring fishery at Paliryuak River may be from the Ekalluk system. A decline in length and age was noted in the 1990 sample from this fishery as well. Details will be discussed under Paliryuak River in this document.

Waters	1989/90 Quota/Harvest	1990/91 Quota/Harvest	1991/92 Quota

9. Ekalluk River (cont'd)

In summary, there appears to be a trend toward a decline in size and age of charr taken by the Ekalluk River fishery. This stock is believed to be the most heavily exploited of the Cambridge Bay stocks at present. As a precautionary measure, it is recommended that the Ekalluk River quota for 1991 be reduced by 7 000 kg to 7 500 kg, round weight. Area staff are presently meeting with the resource users in Cambridge Bay to discuss the implications of this recommendation. This stock must be monitored in 1991.

10. Ellice River	6 000/5 969	6 000/6 371	8 000 (6 400)*

The stock in this mainland river is harvested by the Cambridge Bay commercial fishery. This stock appears to be doing well. In the past, mean annual harvest was 12 000 kg (1971-77). This led to a decline in the mean size of charr in the catch and annual quotas were eventually reduced to 4 500 kg. This measure appears to have led to a recovery (increase in mean size and the quota was subsequently increased to 6 000 kg in 1988. During the last three years the quota was taken with no trouble. A sample of the catch was taken in 1990 (N = 208). Modal length (600 - 650 mm) was consistent with 1989, as was modal age (11 y). Mean length increased significantly (t-test, $P<0.001$) to 656 mm from 626 mm in 1989 as did the length-frequency distribution (Chi-square, $P<0.001$). No difference in mean age (10.9 y) or age-frequency distribution was noted. This quota was over-harvested by 297 kg in 1990. The quota was fished from Aug. 24 to Aug. 27 for a total of 4 days of fishing. One family group of three fished this quota apparently with a total of 4 x 91 metre 139 mm mesh gill nets. Although an annual harvest of 12 000 kg was excessive in past, 6 000 kg appears to be sustainable. In an effort to offset the 7 000 kg reduction in harvest recommended for the Ekalluk River for 1991, it is recommended that the quota on the Ellice River be increased to 8 000 kg, for the next few years. Annual monitoring is recommended as well.

13. Halovik River	6 800/6 857	6 800/6 971	6 800 (5 500)*

Charr harvested at this location by the Cambridge Bay commercial fishery are considered to be part of the Wellington Bay stock complex although there is a possibility that a discrete stock exists here. In 1981, 21 000 charr were counted in the upstream run. Tag returns from the commercial fishery the following year indicated minimum exploitation rate was 5%. This fishery takes place in the estuary in July and tag returns indicate that Ekalluk River charr contribute to this fishery as well. Therefore, the sample from the commercial catch is an mixture and must be interpreted with care. Similar to the Ekalluk samples, a decline in size was noted here between 1987 and 1988. However, unlike

Waters	1989/90 Quota/Harvest	1990/91 Quota/Harvest	1991/92 Quota
13. Halovik River (cont'd)			

the Ekalluk sample which showed an increase in 1989, the Halovik sample length continued to decline in 1989. Mean length fell from 695 mm in 1988 to 668 mm in 1989 (t-test,P<0.001). The length distribution decreased as well (Chi-square, P<0.001). In 1988, 82% of the charr in the sample were 650 mm or larger. In 1989, that proportion fell to 59%. The mean age declined from 15.6 to 14.6 years (t-test, P<0.001). Forty-eight percent of the charr were 15 years or older in the 1989 sample compared with 65% in 1988 (Chi-square, P<0.01). Instantaneous total mortality for ages 15-20 years rose from 0.31 in 1988 to 0.44 in 1989. The fishermen reported the fishing to be fairly good with the quota being taken in 8 days. It is recommended that the annual quota remain at 6 800 kg and that the catch be monitored annually to determine if a trend toward an overall decline in the fishery is developing. Biochemical studies should be conducted here to confirm the existence of a discrete stock. No samples were obtained in 1990. This quota is fished from July 12 July 17 for a total of 6 days. Three fishermen fished this quota with 4x91 meter gill nets of 139 mm mesh size.

14. Jayco River	13 600/12 866	13 600/12 865	18 600 (14 880)*

This stock is harvested by fish weir during the fall upstream run. The 1990 fishery took place over 12 days (Aug. 30 - Sept. 10) and fell short of the quota by about 600 kg. The shortage is not believed to be due to a lack of fish. There was no significant difference in age composition between the 1988, 1989 and 1990 samples. Modal age was 16 y. Length showed a decline between 1988 and 1989 (Chi-square, P<0.001) but increased in 1990 (P<0.001). Mean length increased to 658 mm from 628 mm in 1989 (t-test, P<0.001). Modal length increased to 650 - 700 mm from 600 - 650 mm in 1989. Eighty-four percent of the 1990 sample was 600 mm in length or larger compared with 72% in 1989. Instantaneous total mortality calculated for ages 17 - 22 years in 1989 was 0.23 compared with 0.40 for ages 17 - 23 years in 1990. This is the second largest stock (count of 139 000 upstream migrants in 1981) in the Cambridge Bay area and results of tagging indicated exploitation was light (4%) in 1982. Since that time the annual harvest has been at or below the 13 600 kg quota. Given the size of this stock and the light exploitation to date, it is recommended that the annual quota be raised by 5 000 kg to 18 600 kg for 1991 and the next few years in order to offset the reduction in the 1991 quota for the Ekalluk River. This stock must be monitored in 1991.

Waters	1989/90 Quota/Harvest	1990/91 Quota/Harvest	1991/92 Quota
16. Kagloryuak River	4 500/NF	4 500/NF	875 (760)

This river is located a considerable distance from the community of Holman and is often difficult to access by boat in summer due to ice conditions in Prince Albert Sound. Therefore, it is not fished on a regular basis. A harvest of 4 458 kg was reported for 1983 when a float-equipped aircraft was available to transport the catch to Holman. Although no data are available, the charr were reported to be small. A sample (N = 33) was taken from the Kagloryuak in 1985 during a test-fishery on three nearby river systems. Modal length was 400 - 450 mm, range 380 - 630 mm. Modal age was 9 years, range 7 - 14 years. The mean length was 500 mm and mean age was 10.3 years. Mean weight was 1.47 kg. The sex ratio was nearly equal. No fishing took place in 1989. However, the upstream run was enumerated by fish weir in 1990 and only 13 072 upstream migrants were counted. A high incidence of net marks suggests that this stock may already be subjected to harvest by other fisheries in Prince Albert Sound. Therefore, a biannual harvest of 875 kg is recommended at present. See Fish Subcommittee report for 1990/91 for more details.

17. Keith Bay	4 500/1 185	4 500/NA	4 500 (3 900)

This stock is fished during the winter by residents of Pelly Bay. It was last sampled in 1985 and appeared to be in good condition. It has been lightly fished during the last few years. The low harvest is due to the practise of fishing out the deep holes in the river where some charr overwinter. These holes are fished out before the quota is reached. Fishing in the large lakes where most of the charr apparently overwinter is not successful since the charr do not move around enough to get caught.

18. Kellett River	1 000/907	1 000/907	1 000 (900)

Biological data indicated that this stock was overexploited by 1979/80. As a result, the quota was reduced from 16 000 kg to 9 100 kg in 1980. Following two years of very low harvest, no commercial fishing was allowed in 1982 and 1983. A nominal quota of 500 kg was recommended in 1984 to determine whether the stock was recovering. The quota was raised to 1 000 kg in 1985. A sample of the catch indicated that the stock had not recovered. This stock supports a perennial subsistence fishery, but reliable estimates of the harvest are not available. The 1 000 kg quota has been taken each year since 1985 during a winter fishery. Field services remains unable to get in here in the fall to get a sample and train someone to continue doing a sample program. There are no R.R.O.'s here as well. Somehow this fishery continues to hold up in spite of the apparent large subsistence harvest (amount unknown).

Waters	1989/90 Quota/Harvest	1990/91 Quota/Harvest	1991/92 Quota
20. Kulgayuk River	not opened	not opened	1 500 (1 300)

This fishery was opened in 1988 but not fished. There was no request to fish here in 1989. The existence of a stock at this location is somewhat questionable. No record of a harvest is available.

21. Kuujjua River	600/NF	600/NF	600 (500)

The major fishery on this river is subsistence, by the residents of Holman. A biological sample was obtained in 1987. Modal length was 600 - 650 mm, range 505 - 817 mm. Modal age was 13 years, range 10 - 19 years. Mean length was 640 mm and mean age was 13.8 years. Mean round weight was 3.0 kg. These data suggest that the stock was not overexploited at this time. Given the importance of the subsistence fishery, a nominal commercial quota of 600 kg is recommended. No commercial fishing this year as saleable harvest came from a test fishery. However, residents continue to request an increase in the commercial quota. An increase should not be considered until the status of this stock and the extent of the subsistence fishery have been determined. A TAC can then be set whereby charr surplus to subsistence needs will be available for commercial harvest. The commercial harvest of 600 kg was taken in 1990. Plans for 1991 include enumeration of the upstream migration using a fishing weir.

22. Lauchlan River	9 100/9 184	9 100/8 938	9 100 (7 300)*

This location is harvested by the Cambridge Bay commercial fishery and is considered to be part of the Wellington Bay stock complex. However, a small upstream run (11 000), which may represent a discrete stock, was enumerated here in 1983. It is presently believed, based on tag returns, that Ekalluk River charr contribute in a major way to this fishery. This fishery generally takes place in July in the estuary and as such, harvests Ekalluk charr as they feed along the coast. Samples from the commercial fishery are likely to be a mixture of the two stocks and must therefore be interpreted with caution. Although the relative contributions of the stocks to the catch are not known, tag returns in 1984, from charr tagged while migrating upstream in the Lauchlan River in fall 1983, suggest that this stock is rather heavily exploited (11 - 12%). The decline in the length observed in other Cambridge Bay stocks is evident here as well. The decline began in 1987 and has continued into 1989. A sample (N = 104) was taken from the 1990 commercial fishery. Although mean age continued to decline to 13.9 years from 14.6 in 1989 (t-test, P<0.02) and correspondingly, age-frequency distributions were significantly different (Chi-square, P<0.001), mean length increased to 702 mm from 673 mm in 1989 (t-test, P<0.001). Modal age was 650 - 700 mm, up from 600 - 650 mm in 1989. Thus, length-frequency

Waters	1989/90 Quota/Harvest	1990/91 Quota/Harvest	1991/92 Quota

22. Lauchlan River (cont'd)

distribution differed as well (Chi-square, P<0.001). As stated previously, there may be no simple explanation for the observed changes, given the possibility that samples are comprised of an admixture of stocks. Given the possibility that the catch from this fishery is comprised to some extent by charr from the Ekalluk River, and that the Ekalluk stock may be in decline, no increase is recommended in the quota for the Lauchlan River at this time. Additionally, this stock must be monitored in 1991.

Biochemical studies should be conducted to determine the existence of a discrete stock at this location. Since fishing the upstream run in the fall is more likely to harvest Lauchlan River charr rather than charr from other systems, an annual harvest of 9 100 kg would probably be excessive if the fishery took place in fall, given the apparent small size of this stock. It is therefore recommended that fishing take place in spring (July) to lessen the impact on the Lauchlan stock. Tagging on the upstream run in the Lauchlan River should be considered. Subsequent returns the following year from the fishery should reveal current minimum exploitation level, which when compared with previously-determined levels, will help to measure the impact of fishing on this stock. This quota was fished from July 13 to July 19 for a total of seven days of fishing. It was fished by three family groups with a total of 6 x 91 metre 139 mm mesh gill nets.

23. Lord Lindsay Lake	2 500/4 737	2 500/NA	2 500 (2 200)

This stock, fished by residents of Spence Bay supports a sport, subsistence and commercial fishery. As a result, the commercial quota was reduced from 3 000 kg in 1987 to 2 500 in 1988. Commercial fishing takes place in the winter. Reliable harvest statistics on the subsistence fishery are not available. Although no problems have been reported from this fishery, a sample of the commercial catch should be taken in the near future to determine the status of the stock and the extent of the subsistence fishery should be determined.

25. Murchison River	9 100/NF	9 100/NF	9 100 (7 900)

This stock has been fished by residents of Spence Bay and Gjoa Haven and was requested to be opened for 1989 and 1990. It was not fished, as it was too expensive to haul fish to market. It was apparently last fished in 1988 with a harvest of 2 700 kg. There do not appear to be any problems with this stock.

Waters	1989/90 Quota/Harvest	1990/91 Quota/Harvest	1991/92 Quota
26. Norway Bay	2 500/NF	2 500/NF	4 500 (3 900)

Cambridge Bay fishermen requested that this fishery be opened for 2 500 kg in 1990 but did not fish it due to logistical problems.

Waters	1989/90 Quota/Harvest	1990/91 Quota/Harvest	1991/92 Quota
27. Paliryuak River	9 100/9 176	9 100/9 318	7 100 (6 000)

This location is fished by the Cambridge Bay commercial fishery. Charr taken by this fishery are believed to be part of the Wellington Bay stock complex. To date there is no evidence of a substantial upstream run of charr in this river. Tagging studies revealed that the bulk of the catch at this location is charr from the Ekalluk River system. Fishing takes place in the estuary in July when Ekalluk River charr are feeding in the nearshore areas. As expected, characteristics of the commercial sample are very similar to those from the Ekalluk. Mean length began to decline in 1986 and continued in 1987 and 1988 followed by a significant increase in 1989. Mean length increased from 649 mm in 1988 to 666 mm in 1989 (t-test, $P<0.001$). There was no difference in mean age between those years. Although the absolute values were higher at Paliryuak than at Ekalluk (666 mm vs 640 mm in 1989 and 649 mm vs 611 mm in 1988), the increase in length at each location was similar (Ekalluk = 29 mm, Paliryuak = 17 mm). The difference in the absolute values is thought to be due to the behaviour of the feeding migrants. The largest charr appear to migrate to sea first and travel the greatest distance from their overwintering stream to feeding areas. It is the larger charr from the Ekalluk that are probably being picked up by the July fishery at Paliryuak River. The Ekalluk River fishery takes place on the upstream fall run where all size categories are encountered. Hence the mean size is smaller. In 1990, this quota was fished from July 12 to July 20 for a total of nine fishing days. Fished by two family groups using a total of 4 x 91 metre 139 mm mesh gill nets. A total of 210 charr were sampled in 1990. The data reveal no significant difference in mean length (t-test, $P>0.05$) between 1989 and 1990. Mean length in 1990 was 658 mm. There was no significant difference in length-frequency distribution either (Chi-square, $P>0.05$). Modal length was constant at 650 - 700 mm. There was, however, a significant difference in mean age ($P<0.001$) (13.2 y vs 14.6 y in 1989) and age-frequency distribution ($P<0.001$). Modal age dropped to 14 y from 15 y the previous year. The stability of the length-frequency distribution can perhaps be explained by the size segregation of the feeding charr discussed previously. Regardless of how many large charr remain in the stock, the largest will move out first and travel the farthest in search of food and thus be the first ones vulnerable to the fishery. The significant shift in the age-frequency distribution, quite similar to that observed in the 1990 sample from the Ekalluk, is perhaps more telling. An increase in annual mortality will result in a decline in age groups represented in the catch. Instantaneous total mortality for ages 14 - 17 years

Waters	1989/90 Quota/Harvest	1990/91 Quota/Harvest	1991/92 Quota

27. Paliryuak River (cont'd)

was 0.70 in 1990 compared with 0.55 in 1989. This observation supports the possibility that indeed the Ekalluk stock is in decline. As such, it is recommended that the quota for the Paliryuak River be reduced by 2 000 kg to 7100 kg in 1991 as a precautionary measure. In total, this should result in a reduction of 9 000 kg in the harvest on the Ekalluk stock in 1991. The implications of this change will be discussed with the Cambridge Bay fishermen prior to the start of the 1991 fishing season.

29. Perry River	4 500/NF	4 500/NF	6 500 (5 200)

This location has, in past, been part of the Cambridge Bay commercial fishery but it has not been commercially fished since 198[illegible]. It was heavily fished in the past and the quota was reduced from 11 300 kg in 1980 to 6 800 kg in 1981 in response to a decline in the mean length and age of the catch. The last year of commercial harvest produced 2 800 kg, far short of the quota. Cambridge Bay fishermen requested that this location be opened in 1989, for 4 500 kg. However, it was not fished, apparently because of logistic problems. It is the most distant fishing location from Cambridge Bay (160 km). Although the extent of subsistence harvesting at this location is not known, the absence of commercial fishing for eight years should have allowed the stock to recover. It is recommended that an annual quota of 6 500 kg be allowed at this site if interest in fishing here is renewed. This will make the site more economically attractive to harvest, given the distance from Cambridge Bay. Given the past history of the fishery and the long period during which no fishing took place, there should be no problems with the stock at the recommended level of harvest. If it is fished in 1991, a biological sample will be taken.

30. Port Parry	1 000/600	1 000/272	1 000 (900)

Residents of Gjoa Haven fish this location for subsistence purposes. A commercial quota of 2 300 kg has been allowed as well. The fishery failed in 1987 and was not opened in 1988. Apparently the subsistence fishery did poorly in 1988. A test fishery was conducted here in October, 1989 with a provisional quota of 1 000 kg. The harvest was 600 kg. Fishermen reported that the run had returned to normal and attributed the problems of the previous two years to low water which forced the charr to overwinter in another system. There is no documented evidence for this occurrence. However, it is not altogether unlikely. A sample of the test harvest (N = 89) revealed a mean length of 635 mm, modal length of 600 - 650 mm. A very small sample (N = 13) of age showed mean age at 16.7 years and modal age at 17 years. Eighty percent of the charr in the sample

Waters	1989/90 Quota/Harvest	1990/91 Quota/Harvest	1991/92 Quota
30. Port Parry (cont'd)			

were 600 mm in length or larger. An additional sample, from the subsistence fishery (102 mm mesh gillnets), showed mean length as 548 mm (N = 98) and modal length of that catch at 500 - 550 mm. No historical data are available from this stock to compare with the 1989 data. Charr taken in 1989 were certainly of desirable commercial size and catch per unit effort (11 charr/100 m/24 h) suggests that they were relatively abundant at the time of fishing. Given the importance of the subsistence fishery, it is recommended that the annual commercial quota remain at 1 000 kg until there is additional evidence that this fishery has recovered. A sample should be taken in the near future and the extent of the subsistence fishery should be documented. The R.R.O. was able to get a sample from Port Parry in Nov./90. The 272 kg reported is from this sampling expedition. Other fishermen are expected to harvest more charr here. DFO has not yet received the data but the R.R.O. reported the run was normal.

Waters	1989/90 Quota/Harvest	1990/91 Quota/Harvest	1991/92 Quota
32. Simpson River	4 500/NF	4 500/NF	4 500 (3 900)

This area was requested to be opened for 1990/91 by fishermen from Gjoa Haven. There was no reported fishing during the past season, apparently due to logistic problems. The site is 225 km from the community. Little is known of this stock.

Waters	1989/90 Quota/Harvest	1990/91 Quota/Harvest	1991/92 Quota
33. Stanwell-Fletcher Lake	6 800/4 000	6 800/4 000	6 800 (5 900)

This location is fished by residents of Creswell Bay outpost camp. Records indicate that commercial fishing has been light in the past, but most commercial harvest probably goes unrecorded (i.e. unofficial sales to base personnel). Domestic fishing pressure is unassessed but probably high. In addition, itinerant sport fishermen fly in from Resolute to fish the stock. Studies in 1975 and 1976 showed overexploitation but a sample in 1988 showed no signs of same. Recommend effort be spent to collect accurate harvest statistics for this stock.

Waters	1989/90 Quota/Harvest	1990/91 Quota/Harvest	1991/92 Quota
36. Thomsen River Banks Island	not opened	not opened	1 400 (1 200)

There have been no requests to open this area in the recent past. Little is known of this stock.

Waters	1989/90 Quota/Harvest	1990/91 Quota/Harvest	1991/92 Quota
40. Unnamed River East of Ellice	not opened	not opened	nil

The existence of a stock at this location is uncertain at this time. Therefore, no quota is recommended.

41. Unnamed River Dease Point	2 500/NF	2 500/NF	2 500 (2 200)

Very little is known of the stock in this area. It was apparently fished in 1972, 1974 and 1976, but has not been fished commercially since then. The location was requested opened for 1990/91 by fishermen from Cambridge Bay, but it was not fished due to logistic problems.

142. Unnamed River and Lake	not opened	not opened	900 (800)

No interest in fishing this area. No data available on this stock.

143. Unnamed River Cape Adelaide	not opened	not opened	4 500 (3 900)

No interest in fishing this area. No data available on this stock.

144. Unnamed River Collinson Peninsula	not opened	not opened	4 500 (3 900)

Last fished in 1979. No interest in fishing this area at present. Last sampled in 1979, modal length was 700 - 750 mm, mean length was 716 mm (N = 46). Size range was 550 - 850 mm. Modal age was 18 years, mean age was 17.8 (N = 29). Age ranged from 13 - 23 years.

<table>
<tr><th>Waters</th><th>1989/90
Quota/Harvest</th><th>1990/91
Quota/Harvest</th><th>1991/92
Quota</th></tr>
<tr><td colspan="4">REGION V - KEEWATIN (See Fish Subcommittee report for 1989/90 for details)</td></tr>
<tr><td>1. Alden Lake and River</td><td>not opened</td><td>not opened</td><td>900
(800)</td></tr>
<tr><td colspan="4">No interest in fishing this area. No data available on this stock.</td></tr>
<tr><td>4. Baker Foreland Area</td><td>4 600/4 845</td><td>4 600/1 689</td><td>4 600
(4 000)</td></tr>
<tr><td colspan="4">This area is fished by residents of Rankin Inlet. The stock that supports this fishery is assumed to overwinter in the Josephine River. The previous 2 300 kg quota was raised to 4 600 kg in 1987 after the communities of Rankin Inlet and Chesterfield Inlet agreed to split the Josephine River quota between their traditional fishing areas. As a result, fishing no longer takes place at the Josephine River per se, but at Baker Foreland to the south and Fish Bay to the north. The mean annual harvest for the last 5 years was 2 900 kg. The 4 600 kg quota was taken each year for the last 2 years. The commercial catch has been sampled in 1979 and 1986-90 inclusive. Results indicate modal length has remained constant at 550 - 600 mm. Mean length and age have varied little during this period. Mean length in 1990 was 602 mm, mean age 10.0 years. Modal age was 10 years. No problems have been identified here.</td></tr>
<tr><td>7. Belcher Islands</td><td>not opened</td><td>not opened</td><td>nil</td></tr>
<tr><td colspan="4">Residents of Sanikiluaq at one time fished this area commercially but then decided against it. There has been some interest expressed in reviving the commercial fishery, but no quota is recommended until a request has been received to open the fishery. If opened, this fishery will be given exploratory status to obtain a biological sample.</td></tr>
<tr><td>8. Bennett Bay Wager Bay</td><td>2 300/NF</td><td>2 300/NF</td><td>2 300
(2 000)</td></tr>
<tr><td colspan="4">This area was requested opened by fishermen from Repulse Bay in 1989/90 and 1990/91. It was not fished in 1989/90. Fishing may occur in winter 1990/91. Little is known of this stock.</td></tr>
<tr><td>9. Big River</td><td>not opened</td><td>not opened</td><td>900
(800)</td></tr>
<tr><td colspan="4">This area has been requested open in past but there appears to be little interest in fishing here at present.</td></tr>
</table>

Waters	1989/90 Quota/Harvest	1990/91 Quota/Harvest	1991/92 Quota
13. Brown River	6 800/NF	6 800/NA	6 800 (5 900)

This area was opened in 88/89 and 89/90 but not fished. No harvest data is yet available for 90/91. Little is known of the stock. Interest in fishing appears to be poor.

16. Chesterfield Inlet Fish Bay	4 600/5 112	4 600/1 943	4 600 (4 000)

Harvested by residents of Chesterfield Inlet, the previous quota of 2 300 kg was raised to 4 600 kg when the Josephine River quota was divided between this location and Baker Foreland in 1987 (see V-4.Baker Foreland, this document). The stock is assumed to reside in Josephine River. Mean annual harvest over the last five years was 3 514 kg. The present 4 600 kg quota was exceeded by approximately 550 kg during each of the last two years, but harvest was much lower this past year. The commercial catch was sampled in 1987, 1989 and again in 1990. Modal length increased from 550 - 600 mm in 1987 to 600 - 650 mm in 1989, but decreased to 550 - 600 in 1990. Modal age varied from 10 - 11 years during that time. Mean length has remained relatively constant, but mean age decreased from 10.9 to 9.9 yrs from 1989 to 1990. The data are similar to the sample taken from the Baker Foreland catch. The two are assumed to be from the same stock. There does not appear to be a problem with this fishery at this time. The decrease in harvest in 1990 was general for the entire Keewatin fishery, and appeared to be related to poor weather and the availability of other employment opportunities for fishermen.

17. Churchill River Area	500/300	500/NA	500 (400)

This small fishery takes charr in the Churchill River/Button Bay area as they move along the coast feeding in summer. The overwintering location of these charr is not known at this time. The fishery is not a concerted effort, but rather sporadic in nature. Accurate harvest data are not readily available, but harvest was estimated at 300 kg in 1989/90. No harvest data for 1990/91 available at this time.

18. Christie Lake	not opened	not opened	900 (800)

No interest has been expressed in fishing this location. Little is known of the stock.

Waters	1989/90 Quota/Harvest	1990/91 Quota/Harvest	1991/92 Quota
19. Cleveland River Area	summer 6 100/NF	summer 6 100/NF	6 100 summer (5 300)
	winter 3 000/NA	winter 3 000/500	3 000 winter (2 600)

A freezer boat operation out of Coral Harbour was planned for summer but was not carried out, due to logistic problems. The winter fishery may still be in progress at time of writing. No harvest data are yet available.

20. Copperneedle River	4 500/1 220	summer 4 500/3 023 winter 1 475/NA	4 500 (3 900)

Fished by residents of Arviat, annual harvest over the last 5 years has been low (mean = 1 422 kg) but appears to be increasing steadily. The low catch is apparently due to low effort as other quotas, closer to the community, are available. This year a winter fishery may be attempted, but no harvest data is available at this time. The fishery was sampled in 1988 and 1990, and mean and modal length and age did not vary greatly between these times. In 1990, the catch had a modal length of 550 - 600, a bimodal age distribution of 8 and 10 - 11 yrs, a mean length of 602 mm and a mean age of 9.2 years. Little is known of this stock but it does not appear to be overexploited at this time.

21. Corbett Inlet	4 500/4 500	summer 4 500/835 winter 3 665/NA	4 500 (3 900)

This area has a history of fishing by residents of Rankin Inlet. The quota was not taken in the summer so the area was opened for the remainder of the quota in winter. No harvest data are available for the winter fishery at time of writing. Annual harvest during the last five years has fluctuated from 305 kg in 1986 to 5 440 kg in 1988. Mean is 3 391 kg. The commercial catch was sampled in 1974, 1975-79 inclusive, and 1986-90 inclusive. Modal length has varied from 550 - 600 mm to 600 - 650 mm, modal age from 7 to 10 years. Modal length of the 1990 sample was 550 - 600 mm, mean length was 598 mm. Modal age was 10 years, mean age was 9.1 years. The reason for the low harvest in summer 1990 is not known but harvests were poor throughout the Keewatin this summer. The data from the sample do not provide evidence of overexploitation.

24. Diana Lake	not opened	not opened	nil

This lake is the overwintering area for the Diana River stock which has been overexploited. The Diana River fishery (Rankin Inlet) will remain closed pending evidence of a recovery of the stock. No commercial fishing is recommended for Diana Lake.

Waters	1989/90 Quota/Harvest	1990/91 Quota/Harvest	1991/92 Quota
26. East Point	not opened	not opened	4 500 (3 900)

No interest has been expressed in fishing this area. Little is known of this stock.

28. Eskimo Point	4 500/3 721	4/500/291	4 500 (3 900)

Residents of Arviat fish this area in summer. Most of the quota was taken last year but harvest was very low this summer. Samples of the commercial catch indicate that the modal length has decreased from 600 - 650 mm in 1989 to 550 - 600 mm in 1990. Modal age was 10 yrs in 1989, and was bimodal with a large mode at 7 - 8 yrs and a small mode at 11 yrs in 1990. It appears that a strong year class is entering the fishery. Mean length of the 1990 sample was 581 mm and mean age, 8.3 years. These data must be interpreted with caution, however. The fishery takes place in salt water in summer while the charr are feeding along the shore. The sample could represent an admixture of charr from several stocks. The stock supporting this fishery was thought to overwinter in the neighbouring Maguse River until investigations in 1988 and 1989 revealed that there does not appear to be a significant upstream run of charr in the Maguse. Charr tagged during the Arviat fishery in 1989 have been recovered in a commercial catch at Ferguson River later that summer. Curiously, the length and age distributions are quite different than those found at Ferguson River this summer (see below), which may indicate that other stocks are entering the fishery. The reduction in catch was general for the Keewatin this summer, and is impossible to interpret without effort data. Although no changes to the quota are recommended for 1991/92, the situation should be monitored closely. Adjustments may be necessary in future, pending further stock identification studies.

29. Ferguson River	13 600/11 412	summer 13 600/8 452 winter 5 150/NA	13 600 (11 800)

A large stock of charr is believed to overwinter here, although no count has been made of the size of the upstream run. Records of commercial fishing date back to 1962. Mean annual harvest over 20 years is 8 200 kg and ranges from a low of 28 kg in 1986 to a high of 17 373 kg in 1965. The fluctuation is apparently related to effort. Some years there is interest in fishing, other years, not. The site was examined by a DFO technician in August, 1988 to determine if a fish weir could be used here, both for enumerating the run and for commercial fishing. However, the river was too wide for such an operation. The harvest during the last 5 years was well under the quota with the exception of 1989 when 11 412 kg were harvested. Perhaps this is fortunate. Tag returns from the study near Arviat in summer 1989 suggest that the Ferguson River run supports at least two other fisheries (Eskimo Point and Maguse River). Samples of the catch taken

Waters	1989/90 Quota/Harvest	1990/91 Quota/Harvest	1991/92 Quota

29. Ferguson River (cont'd)

periodically since 1974 reveal modal length has fluctuated from 550 - 600 mm to 700 - 750 mm and modal age from 8 to 11 years. Modal length of the 1990 sample was 600 - 650 mm and mean length was 641 mm. Modal age was 11 years, mean age was 10.5 years. These data suggest that the Ferguson River stock is not overexploited at present. However, the size of the stock should be determined in the near future and exploitation should be monitored carefully, especially since the stock appears to be supporting more than one fishery. No change is recommended for the annual quota, but further studies on stock identification and summer migration patterns of Ferguson River charr are needed to prevent overexploitation of this stock in future. Remainder of 1990/91 quota (5 150 kg) open for winter fishery. No harvest data available at this time.

32. Gibson Cove	not opened	not opened	2 300 (2 000)

Last reported commercial harvest in 1983, believed to be fished by residents of Repulse Bay. There appears to be little interest in fishing this area. Little is known of the stock.

33. Gordon River	not opened	not opened	1 100 (1 000)

There appears to be little interest in fishing this area. Little is known of this stock.

34. Gore Bay	3 600/NF	3 600/NA	3 600 (3 100)

Requested open by Repulse Bay fishermen for winter fishery in 1990/91 but no harvest data yet available. No commercial harvest reported for the past 3 years. Little is known of this stock.

36. Hanway River	not opened	2 300/NA	2 300 (2 000)

Opened for winter fishery. No harvest data available. This quota has not been fished since 1983.

Waters	1989/90 Quota/Harvest	1990/91 Quota/Harvest	1991/92 Quota
37. Haviland Bay Area.	2 300/NF	2 300/NA	2 300 (2 000)

Requested open by Repulse Bay fishermen for winter fishery. No harvest data available. This quota not fished since 1987.

39. Josephine River	not opened	not opened	nil

Quota split between Baker Foreland and Chesterfield Inlet (Fish Bay). No commercial fishing is recommended here as a result. However, the status of this stock and the summer migration patterns should be determined in the near future.

40. Kamarvik Creek	not opened	not opened	2 300 (2 000)

This area has not been fished for some time due to lack of interest.

45. Maguse River	4 500/617	4 500/386	4 500 (3 900)

Fished by residents of Arviat, this quota area is adjacent to the Eskimo Point quota area. The 1990/91 harvest fell far short of the quota. The distance fishermen from Arviat have to travel to harvest this quota does have an effect on the interest expressed in fishing it. Apparently interest declines as the season progresses. Similar to the Eskimo Point fishery, a sample of the catch is likely to be a mixture of several stocks and must be interpreted with caution. Sampled each year from 1986-89, modal length has varied from 550 - 600 mm in 1986 to 600 - 650 mm in 1987-89, inclusive. Modal age varied from 8 to 9 years. Mean length in 1989 was 607 mm and mean age was 9.4 years. Charr tagged during the summer fishery here in 1989 were recaptured in the Ferguson River commercial fishery later that year. Although no changes to the quota are recommended for 1991/92, adjustments may be necessary in future, pending results of stock identification studies.

48. Merle Harbour	2 300/91	2 300/0	2 300 (2 000)

This area is fished by residents of Chesterfield Inlet. There was no summer harvest, but the area may be fished this winter. Harvest has been very low in the past, presumably due to lack of interest. Very little is known about this stock, but no specific problems have been identified.

Waters	1989/90 Quota/Harvest	1990/91 Quota/Harvest	1991/92 Quota
49. Mistake Bay	2 300/NF	2 300/NF	2 300 (2 000)

This area was requested open by residents of Whale Cove but was not fished, presumably because of lack of interest. No specific problems have been identified. No commercial harvest reported in past three years. This is a location remote from Whale Cove.

51. North Pole River	not opened	not opened	2 300 (2 000)

This area has a history of commercial fishing dating back to 1969. The last reported commercial harvest was in 1984. Residents of Repulse Bay apparently fished here. The annual harvest does not appear to have exceeded 1 300 kg. Little is known of this stock.

57. Peter Lake	not opened	not opened	nil

The Diana River stock, which has been overexploited, overwinters here. The Rankin Inlet commercial fishery will remain closed pending recovery of the stock. No commercial fishing is recommended for this area.

58. Piksimak River Douglas Hr.	2 300/NF	2 300/NF	2 300 (2 000)

Fishermen from Repulse Bay requested that this fishery be opened but did not fish it due to it's long distance from the community. Last reported commercial harvest was in 1982.

59. Pistol Bay	2 300/1 603	2 300/1 312	2 300 (2 000)

Residents of Whale Cove fish this area. History of commercial fishing here dates back to 1962. Harvest this year was well below the average of the past five years (2 015 kg), a situation common throughout the Keewatin this year. Sampled annually from 1986-89, modal size has risen to 600 - 650 mm in 1989 from 550 - 600 mm for the three previous years. Modal age was nine years in 1986 and 1987 and rose to 10 years in 1988 and 1989. Mean length in 1989 was 602 mm and mean age was 10.1 years. Similar to other commercial fisheries that take place for charr in salt water as they feed along the coast, caution must be used to interpret the data from samples of the catch, given the possibility that it is comprised of an admixture. At any rate, the data discussed here do not provide evidence of overexploitation.

Waters	1989/90 Quota/Harvest	1990/91 Quota/Harvest	1991/92 Quota
63. Ranger Seal Bay	9 100/NF	9 100/NF	9 100 (7 900)

The fishermen of Chesterfield Inlet expressed an interest in fishing this location but decided not to in the end. Little is known of the stock in this area.

64. Rankin Inlet	not opened	not opened	nil

This fishery was supported by the Diana River stock. Steadily declining catches and complaints from fishermen led to its closure in 1985. The upstream migration was enumerated in 1986 and the data were compared with a similar study done in 1976. Results showed that the stock was overexploited. Catch and possession limits for the sport fishery were reduced and a volunteer reduction in subsistence harvest was requested. Test samples using commercial-sized gear (139 mm mesh gillnets) have been taken near the mouth of the Diana River each year since 1985 to monitor the recovery of the stock. Modal length of the sample has risen from 500 - 550 mm in 1985 to 600 - 650 mm in 1990. Modal age has risen from 8 years to 10 years over that time. Mean length has increased from 528 mm in 1985 to 605 mm in 1990. Mean age has increased from 8.3 years to 9.8 years during that time. There were no significant differences in mean length or age between 1989 and 1990. However, age distribution differed significantly (Chi-square, P<0.003) as did length-frequency distribution (P<0.04). In the 1990 sample, 61% of the charr were 10 years or older compared with 45% in 1989. Fifty-six percent of charr in the 1990 sample were 600 mm or longer compared with 47% in 1989. Collectively, these data suggest some recovery of the stock. Enumeration of the upstream migration was attempted in 1990, but high water conditions prevented installation of the weir. Enumeration will be attempted again in 1991. It is recommended that the commercial fishery remain closed, pending results of the 1991 study.

65. Robin Hood Bay	6 800/594	Summer 6 800/NA Winter 6 800/NA	6 800 (5 900)

This area is fished by residents of Chesterfield Inlet. The quota was not fished this summer (1990) but may have been during the winter The annual harvest has fluctuated over the past five years ranging from zero in 1987 to 2 300 in 1986. The mean annual harvest during this time was 1 141 kg. A sample of the 1988 catch revealed a modal length of 550 - 600 mm, modal age of 10 years, mean length of 587 mm and mean age of 10.2 years. Although the data must be interpreted with caution, they do not indicate overexploitation. The poor harvests are believed

Waters	1989/90 Quota/Harvest	1990/91 Quota/Harvest	1991/92 Quota

65. Robin Hood Bay (cont'd)

to be related to lack of interest in fishing this location. Little is known of the stock in this area.

66. Sandy Point	900/470	900/960	900 (800)

This small stock was enumerated for three successive years in the 1970's and the quota is based on that enumeration. The area is fished by residents of Arviat. Harvest has approximated the quota for past eight years. Sampling was attempted this year, but only 17 samples were obtained. No specific problems have been identified, but sampling should be carried out as soon as feasible.

69. Snowbank River	2 300/NF	2 300/NA	2 300 (2 000)

Requested open by residents of Repulse Bay for a winter fishery. Little is known of this stock. The quota has not been fished for years.

71. Steep Bank Bay	4 500/522	summer 4 500/0 winter 4 500/NA	4 500 (3 900)

Fished by residents of Chesterfield Inlet, harvest over the past 4 years has ranged from 18 kg in 1988 to 1 108 kg in 1986, with a mean annual harvest of 589 kg. Fishing may be attempted this winter. The low harvest is believed to be due to low effort. Little is known of this stock.

72. Stony Point Area	6 800/850	6 800/NF	6 800 (5 900)

Fished by residents of Chesterfield Inlet, the low harvest is believed to be due to low effort. The harvest has ranged from nil in 1987 and 1990 to 3 257 in 1988. The mean annual harvest for the past five years is 1 428 kg. The catch was sampled from 1974-77 inclusive and again in 1988. The data must be interpreted with care as they could be from a mixture of stocks. Modal length was down from 550 - 600 mm in 1977 to 500 - 550 mm in 1988. Mean length was down from 611 mm to 568 mm. However, the 1988 length was similar to that for the years 1975 and 1976. The modal age of 10 years was the same in 1977 and 1988 as was the mean age (10.5 years). No problems have been identified. There has been interest expressed to harvest the charr using a weir but a suitable site has not been identified.

Waters	1989/90 Quota/Harvest	1990/91 Quota/Harvest	1991/92 Quota
75. Thomsen River	8 400/3 272	8 400/NF	4 200 (3 700)

The upstream run was enumerated with a weir in 1987 (15 500 charr). The TAC, based on 10% annual exploitation, was set at 4 200 kg. If fishermen agree to fish it every two years, due to economic constraints, the quota will be set at 8 400 kg. This was done in 1989/90 but the actual harvest fell short of the annual quota. A freezer boat operation from Coral Harbour fished there in 1989. However, in 1990/91 logistical problems prevented operation of the freezer vessel.

76. Wallace River	2 300/NF	2 300/206	2 300 (2 000)

This area is fished by residents of Whale Cove. Commercial fishing history dates back to 1972 but harvest has been low. No specific problems have been identified here, thus it is assumed that the low harvest is due to lack of effort.

77. Whale Cove Area	not opened	not opened	nil

This quota was combined with the Wilson Bay quota. Therefore, no commercial quota is recommended for this area.

79. Wilson Bay	summer 7 000/7 179 winter 3 000/NA	summer 8 000/8 103 winter 2 000/NA	summer 7 000 (6 100) 3 000 winter (2 600)

This area is fished by fishermen from Whale Cove. The quota was combined with Whale Cove as it is suspected that the two fisheries harvested the same stock. The summer harvest has been good for the past four years, averaging 6 578 kg per year. The winter fishery has not been as productive. Samples of the catch have been taken each year since 1986. Modal length has varied from 550 - 600 mm in 1986 and 1988 to 600 - 650 mm in 1987, 1989 and 1990. Mean length in 1990 was 616 mm. Modal age has risen from nine years in 1986 to a broad mode of 9-11 years in 1990. Mean age in 1990 was 9.8 years. The recent data do not suggest overexploitation.

81. Unnamed River	not opened	2 300/NF	2 300 (2 000)

No historical data and little known about this stock.

Waters	1989/90 Quota/Harvest	1990/91 Quota/Harvest	1991/92 Quota
82. Unnamed River	not opened	2 300/NF	2 300 (2 000)

Fishery was requested open by Whale Cove residents, but not fished. No historical harvest data are available. Little is known of this stock.

83. Unnamed River	not opened	6 800/NA	6 800 (5 900)

Requested open by Rankin Inlet residents for winter fishery. No historical harvest data are available. Little is known of this stock.

84. Unnamed River	not opened	not opened	6 800 (5 900)

No interest in fishing here. Little is known of stock.

85. Unnamed River Wager Bay	not opened	not opened	2 300 (2 000)

No interest in fishing here. Little is known of stock.

REGION VI - BAFFIN - HIGH ARCTIC

1. Adams Island Lake and River	not opened	not opened	700 (600)

No interest in fishing this location. Has not been fished for some time.

2. Amadjuak Lake	9100/NA	not opened	9 100 (7 900)

This lake has not been fished for many years due to the distance from Iqaluit. Last reported commercial harvest in 1982 (1 500 kg). Sports fishermen catch large (>5 kg) colourful char during the summer which have a high incidence of tapeworms and cysts. These are probably landlocked char. It is not known whether searun char ascend the Amadjuak River from Nettilling Lake to winter in Amadjuak Lake; however, large numbers of searun char have been observed in the lower Amadjuak River.

Waters	1989/90 Quota/Harvest	1990/91 Quota/Harvest	1991/92 Quota
4. Ayr Lake	-	6 800/NF	6 800 (5 900)

Requested open by Clyde river residents. There is no history of commercial harvest, but some domestic fishing occurs at the mouth of the Kogalu River in the summer. It is not known whether searun fish overwinter in Ayr Lake. Winter fishing at the lake is said to be unproductive. The Kogalu River is presently the focus of a GNWT sponsored study to find opportunities for char enhancement in the area.

5. Blandford Bay River	not opened	not opened	900 (800)

No interest in fishing this location. Status of stock unknown. Last reported commercial harvest in 1986 (115 kg).

7. Cape Adair Lake and River	2 300/NA	2 300/NA	2 300 (2 000)

Winter fishery out of Clyde River. No harvest data at time of writing.

9. Clyde Inlet	not opened	not opened	2 300 (2 000)

No interest in fishing this location. Status of stock unknown.

10. Cockburn River	not opened	not opened	5 000 (4 400)

Fished out of Igloolik, commercial fishing dates back to 1977. Harvest has generally been low. Test fished in 1985 and 1986 site appeared to have potential for increased commercial fishing. Logistic problems with summer fishery. Winter fishery considered.

11. Coutts Inlet	900/NA	900/NA	900 (800)

Requested open for summer fishery by residents of Pond Inlet. No harvest due to lack of interest. Quota not fished in recent years.

12. Drewry River and Lake Gillian	not opened	not opened	3 200 (2 800)

No interest in fishing this location. Status of stock unknown.

Waters	1989/90 Quota/Harvest	1990/91 Quota/Harvest	1991/92 Quota
13. Duart Lake and River	not opened	not opened	700 (600)
No interest in fishing this location. Status of stock unknown.			
14. Eque Bay Area	not opened	900/NA	900 (800)
Requested open by Igloolik residents for winter fishing. No harvest data available.			
15. Erchsen Lake (Ravn River)	-	900/NA	9 100 (7 900)
Requested open by Igloolik residents for winter fishery. The quota refers to landlocked char, but it is not known if searun char ascend the Ravn River as far as Erchsen Lake. Winter fishing on the Ravn River occurs downstream of this lake. There is no history of commercial fishing on the lake, and no domestic fishing is reported. Little is known about this stock.			
16. Feacham Bay Lake and River	not opened	not opened	900 (800)
No interest in fishing this location. Status of stock unknown.			
17. Freshwater Lake	4 500/3 405	not opened	4 500
Fished by residents of Pangnirtung, generally during the summer. Harvests have been good over the past five years, averaging 3 885 kg. The HTA decided not to fish the lake commercially this year. Fishermen believe that the fish caught at this site originate at Kipisa Lake (PG004, 66-33 N, 67-57 W). They say they can distinguish these fish by their physical appearance. They therefore decided to cease fishing Freshwater Lake in order to conserve the Kipisa Lake stock. Their is no scientific information to support or refute their belief. Freshwater Lake is actually an arm of the sea which receives saltwater input for at least part of the month. Although the surface layer is fresh, it is likely that the deeper layers are saline. It is not known if charr overwinter in the lake, but they do congregate near the outflow during the summer. Observations should be made during the fall to determine whether or not there is an upstream run.			

Waters	1989/90 Quota/Harvest	1990/91 Quota/Harvest	1991/92 Quota
18. Gifford River	3 600/3 600	3 600/NA	3 600 (3 100)

Winter fishery out of Igloolik. Fishery ongoing, no harvest data at time of writing. Fishing last year reported to be good, and the full quota was harvested. Commercial catch over the past five years has averaged 3 200 kg. The local Renewable Resource Officer estimates domestic harvest at 3 000 kg annually. Sampling was carried out in 1990. Age distribution was bimodal with modes at 16 and 21 years. Length distribution was also bimodal with modes at 600 - 650 and 700 - 750 mm. Mean age and length were 18.7 and 666 mm respectively. These data are not indicative of overexploitation. The fishery appears to be able to sustain an annual harvest of at least 6 000 kg. Recommend accurate subsistence harvest data be collected if possible.

19. Hall Lake	9 000/8 000	summer 9 000/1 400 winter 7 600/NA	9 000 (7 800)

Winter fishery out of Hall Beach. Winter fishery ongoing, no harvest data at time of writing. It is likely that the commercial harvest is under-reported, since an unknown amount of fish is exported via the North Warning Site. The 1989 harvest was estimated at 8 000 kg. The stock also supports a subsistence harvest estimated at 2 - 3 000 kg and a sport harvest of unknown quantity. The fishery may be targeted this winter by GNWT for economic development. Recommend an Hall improvement in the collection of commercial harvest statistics, possibly by contacting North Warning Site personnel.

20. Iqaluit River Tay Sound	2 300/2 599	2 300/2 000	2 300 (2 000)

Fished in early winter by residents of Pond Inlet. Some concerns about stock. The local Renewable Resources Officer reports that the subsistence harvest may exceed 10 000 kg. Upstream run was enumerated in 1989. Run large (282 500 charr) but mean size small. Preliminary analysis indicates presence of few old charr and relatively high mortality suggesting stock shows signs of heavy exploitation. History of commercial fishing dates back to 1974. Fishery has been a steady producer. Recommend commercial quota remain at 2 300 kg pending completion of analysis. Commercial/subsistence fisheries should be monitored in 1990. A background document on this stock will be prepared for AFSAC for 1992.

21. Ikalojuak Bay Area	not opened	not opened	nil

Residents of Pangnirtung request that this fishery remain closed.

Waters	1989/90 Quota/Harvest	1990/91 Quota/Harvest	1991/92 Quota
22. Irvine Inlet	not opened	not opened	4 500 (3 900)

This fishery has been a steady producer in the Pangnirtung area, with commercial harvest averaging 3 170 kg over the past five years. The stock also supports an unknown but probably significant domestic harvest. It has been fished during the winter in recent years. Harvest data are not yet available for this year. Sampling will be attempted this winter.

23. Isortog River and Lake	5 000/NA	5 000/NA	5 000 (4 400)

Winter fishery out of Igloolik, in progress. No harvest data at time of writing. Last recorded commercial harvest was in 1986. Annual domestic harvest is estimated at 2 500 kg, taken primarily by the nearby outpost camp.

24. Kingnait Fjord	1 000/7 600	1 000/NA	1 000

Fished by residents of Pangnirtung during the winter, this stock also supports a sports fishing camp and an unknown but probably significant domestic harvest. Commercial harvest has exceeded the quota for the past two years; last years harvest was 7 600 kg. Last year 27 fishermen were licensed to fish the system, and the quota was exceeded in a matter of days, before it could be closed. This year, negotiations with the HTA resulted in a limited entry system and a reduced quota. Four fishermen will be licensed to fish the 1 000 kg quota. The stock was last sampled in January 1986 by test gang. Modal length was 500 - 550 mm, modal age was 12 yrs. Mean length and age were 514 mm and 12.1 yrs. The stock did not appear to be overexploited at that time. Recent reports from fishermen suggest that larger fish are less frequently caught than in former years. Fishing had not yet begun at time of writing. The fishery will be sampled this year, and next year's quota will depend partially on the results of this study.

25. Kipisa Lake	not opened	1 400/1 182	1 400 (1 200)

The quota for this fishery was taken twice during the fishing year 1988/89, once in winter and once in summer. The 1989/90 recommendation was to keep it closed until January, 1990, however no commercial harvesting occurred in 1989/90. The stock also supports an unknown, but probably small domestic harvest. There is some conflict over access to this quota between Pangnirtung Kipisa Lake and Iqaluit fishermen. The Pangnirtung HTA has recently decided to fish the lake in the late fall, when it is not accessible to Iqaluit fishermen. The fishery has been a steady producer in the Pangnirtung area, with harvests averaging 1128 kg annually over the last five years fished. The fishery was sampled as a test

Waters	1989/90 Quota/Harvest	1990/91 Quota/Harvest	1991/92 Quota
25. Kipisa Lake (cont'd)			

fishery in 1980 and again by DFO personnel in April 1990. These data are not directly comparable, however, as 114 mm mesh net was used in the 1990 test. Modal length decreased from 600-650 in 1980 to 550 - 600 in 1990. Conversely, modal age increased from 14 - 15 yrs to 16 yrs over the same period. These data do not suggest overexploitation.

26. Kukaluk River	3 600/NA	3 600/NA	3 600 (3 100)

Winter fishery out of Igloolik, in progress. No harvest data at time of writing. Domestic fishing pressure is reported to be light at roughly 200 kg annually. Production is said to be good, and the full quota has been harvested for the past two years. The Igloolik HTA has in the past requested an increase in the quota. Sampling will be carried out this year if possible.

27. Lethbridge Lake and River	not opened	not opened	1 400 (1 200)

No interest in fishing this location. Status of stock unknown.

28. Nedlukseak Fjord	not opened	not opened	nil

This location is within the boundaries of Auyuittuq National Park. No commercial fishing recommended here. The fishery has been submitted for removal from Schedule V of the NWT Fishery Regulations. The system is fished domestically by residents of Broughton Island, with harvests estimated at 900 - 1 400 kg annually. Overharvesting has occurred in the past, and in 1980 the HTA closed the commercial fishery and imposed a voluntary 100 lb/family domestic harvest rule. Test netting was carried out in January, 1990, by the local Renewable Resource Officer, unfortunately using 100 mm mesh nets. Modal length and age were therefore low, but some large (600 - 650 mm) old (14 - 18 yrs) fish were caught. This suggests that the stock may have recovered somewhat, but the lack of comparative data precludes any definitive conclusions.

30. Newton Fjord Area	not opened	not opened	2 300 (2 000)

No interest in fishing this location. Status of stock unknown.

Waters	1989/90 Quota/Harvest	1990/91 Quota/Harvest	1991/92 Quota
31. Nettilling Lake	22 700/nil	summer 22 700/5 172 winter 17 500/NA	22 000 (19 000)

This location was fished in earnest from 1974-77, inclusive. A harvest of 600 kg was reported in 1982. Since then little fishing has taken place here. An attempt was made to harvest charr in fall, 1990 by means of a fish trap at the Nikku Island fishing site. The trap was deployed successfully, but most of the harvest was taken by means of gill nets. The trap tended to catch many small char, which were released alive. The fishery may continue next year if it proves to be economically viable. The area was open for winter fishing by the Pangnirtung HTA, but it is doubtful that any fishing will take place. See report on this stock in the 1990/91 Fish Subcommittee section.

32. Nudlung Fjord	4 500/600	summer 4 500/142 winter 4 350/NA	4 500 (3 900)

This area was requested open by residents of Broughton Island. Commercial harvests have been low or non-existent in the past, and domestic harvest is estimated at about 2 000 kg annually. Reported harvest for 1989 was 600 kg, and all fishing took place during the winter. The low harvests are general for Broughton and are related to a lack of market for commercial fish. No winter harvest data available at time of writing.

33. Okalik Bay	1 400/219	not opened	1 400 (1 200)

Winter fishery out of Iqaluit has not been requested this year. No reported harvest at time of writing. Harvest in 1988 reported to be 1 310 kg, in 1989 it was 219. No problems with this fishery.

34. Padle River	3 600/NF	3 600/NF	nil

Fished in past by residents of Broughton Island. Reported commercial harvest in 1988 was 900 kg. Estimated subsistence harvest 1 600 kg. This stock is believed to be the same on that is exploited by the Kingnait Fjord (VI-24) fishery. Since the latter was overfished in 1989 this area was closed to commercial fishing before the 1989 harvest took place.

Waters	1989/90 Quota/Harvest	1990/91 Quota/Harvest	1991/92 Quota
35. Padle Fjord	3 600/2 464	3 600/NA	3 600 (3 100)

Fished by residents of Broughton Island. Reported harvest in 1989 was 2 464 kg. Extent of subsistence fishery unknown but estimated at 2 000 kg. Quote likely to be fished this winter (1990/91).

Waters	1989/90 Quota/Harvest	1990/91 Quota/Harvest	1991/92 Quota
36. Padloping Island	not opened	not opened	900 (800)

No interest in fishing this location. Status of stock unknown.

Waters	1989/90 Quota/Harvest	1990/91 Quota/Harvest	1991/92 Quota
37. Paquet Bay River and Lake	1 000/NF	1 000/400+	1 000 (900)

Winter fishery out of Pond Inlet, in progress. No harvest data available at time of writing. Was not fished in 1988 or 1989 due to logistic problems.

Waters	1989/90 Quota/Harvest	1990/91 Quota/Harvest	1991/92 Quota
38. Phillips Creek	not opened	not opened	nil

No interest in fishing at this location for many years.

Waters	1989/90 Quota/Harvest	1990/91 Quota/Harvest	1991/92 Quota
39. Piling Lake and River	not opened	not opened	1 800 (1 600)

No interest in fishing this location. Status of stock unknown.

Waters	1989/90 Quota/Harvest	1990/91 Quota/Harvest	1991/92 Quota
41. Qualluatik Lake	700/955	not opened	700 (600)

Winter fishery out of Iqaluit, not requested this year. Reported harvests have averaged 820 kg annually for the past three years. No problems with this fishery.

Waters	1989/90 Quota/Harvest	1990/91 Quota/Harvest	1991/92 Quota
42. Ravn River	9 100/8 500	9 100/NA	9 100 (7 900)

Winter fishery out of Igloolik. No harvest data available at time of writing. Reported harvest for 1989 was 8500 kg, and harvests have averaged 3 700 kg annually for the past five years. The low average harvest is said to be due to the inaccessibility of the fishing site during the winter. Domestic harvest is low, estimated at 200 kg annually. The fishery was sampled in 1985 and 1986 during the summer, and in winter 1990. Modal length remained unchanged at 600 - 650 mm over the period. Modal age also remained at 19 - 20 yrs during all

Waters	1989/90 Quota/Harvest	1990/91 Quota/Harvest	1991/92 Quota
42. Ravn River (cont'd)			

years. Mean age and length also remained stable. There is no evidence of overharvesting of this stock.

43. Rowley River	not opened	5 000/NA	5 000 (4 400)

This Iqloolik winter fishery has not been fished for the past two years, apparently due to logistical problems (inaccessibility). No harvest data available at time of writing. Domestic harvest is reported to be low at roughly 500 kg annually. No problems identified with this fishery.

44. Sam Ford Fjord	3 600/227	3 600/NA	3 600 (3 100)

Winter fishery out of Clyde River, may be still in progress. Reported harvest for 1989 was 227 kg. Low harvest related to low effort due to lack of market for commercial fish. No problems identified here. Extent of subsistence harvest unknown.

45. Saputing Rive	9 100/9 100	9 100/4 028+	9 100 (7 900)

Fished by residents of Arctic Bay, fishery is still in progress. Harvest has averaged 4 800 kg annually for the past five years. Subsistence harvest nil. No problems with this fishery.

46. Tarsuaq Arm	not opened	not opened	2 500 (2 200)

No interest in fishing this location. Status of stock unknown.

48. Tugat River	1 000/nil	1 000/310+	1 000 (900)

Winter fishery out of Pond Inlet, in progress. No harvest data at time of writing. Tagging studies in early 1980's showed this stock to be heavily exploited. As a result quota was reduced to 1 000 kg in 1985. 1988 harvest unknown. The catch should be sampled in 1991 if possible. Subsistence harvest has been estimated at greater than 1 000 kg.

<table>
<tr><th>Waters</th><th>1989/90
Quota/Harvest</th><th>1990/91
Quota/Harvest</th><th>1991/92
Quota</th></tr>
<tr><td>50. Whyte Lake
and River</td><td>900/500</td><td>900/NA</td><td>900
(800)</td></tr>
<tr><td colspan="4">Winter fishery out of Igloolik, in progress. No harvest data available at time of writing. The quota is harvested by a nearby outpost camp. Harvest has been low and sporadic in the past. Last years harvest was 500 kg. Domestic fishing is reported to be light at about 250 kg annually. No problems with this fishery.</td></tr>
<tr><td>51. Unnamed River
(God's Mercie)</td><td>not opened</td><td>not opened</td><td>900
(800)</td></tr>
<tr><td colspan="4">No interest in fishing this location. Status of stock unknown.</td></tr>
<tr><td>52. Unnamed Fjord
(Cumberland Sound)</td><td>1 400/847</td><td>1 400/1 100</td><td>1 400
(1 200)</td></tr>
<tr><td colspan="4">Fished by residents of Pangnirtung during the summer. Fishing reported to be good. No problems with this fishery, but should be sampled if the opportunity arises. Quota not reached in 1989 due to lower effort.</td></tr>
<tr><td>53. Unnamed River
(Kekertelung Island)</td><td>not opened</td><td>not opened</td><td>2 300
(2 000)</td></tr>
<tr><td colspan="4">No interest in fishing this location. Status of stock unknown.</td></tr>
<tr><td>56. Unnamed River
(N of Cape Raper)</td><td>1 400/NF</td><td>1 400/NA</td><td>1 400
(1 200)</td></tr>
<tr><td colspan="4">Winter fishery out of Clyde River, in progress. No harvest data available at time of writing. Not fished for several years due to lack of interest.</td></tr>
<tr><td>58. Unnamed Lake and River
(Dexterity Fjord)
See # 59.</td><td>900/NA</td><td>900/
see below</td><td>close</td></tr>
</table>

Waters	1989/90 Quota/Harvest	1990/91 Quota/Harvest	1991/92 Quota
59. Unnamed Lake and River (Dexterity Fjord)	500/NA	500	2 300 (2 000)

Winter and spring fishery out of Clyde River. This lake and #58 are actually on the same river, but only this lake is actually fished. Last year the Clyde HTA requested that they be allowed to take the combined quota from this lake. Permission was granted, since it was assumed that only one stock was present. This year the HTA has requested an increase in the quota. Permission has been granted on the condition that an Exploratory program is initiated. The quota will be raised to 2 300 kg, and sampling will be carried out this year and 3-5 years in the future.

60. Unnamed River and Lake (Kentra Bay)	not opened	not opened	500 (400)

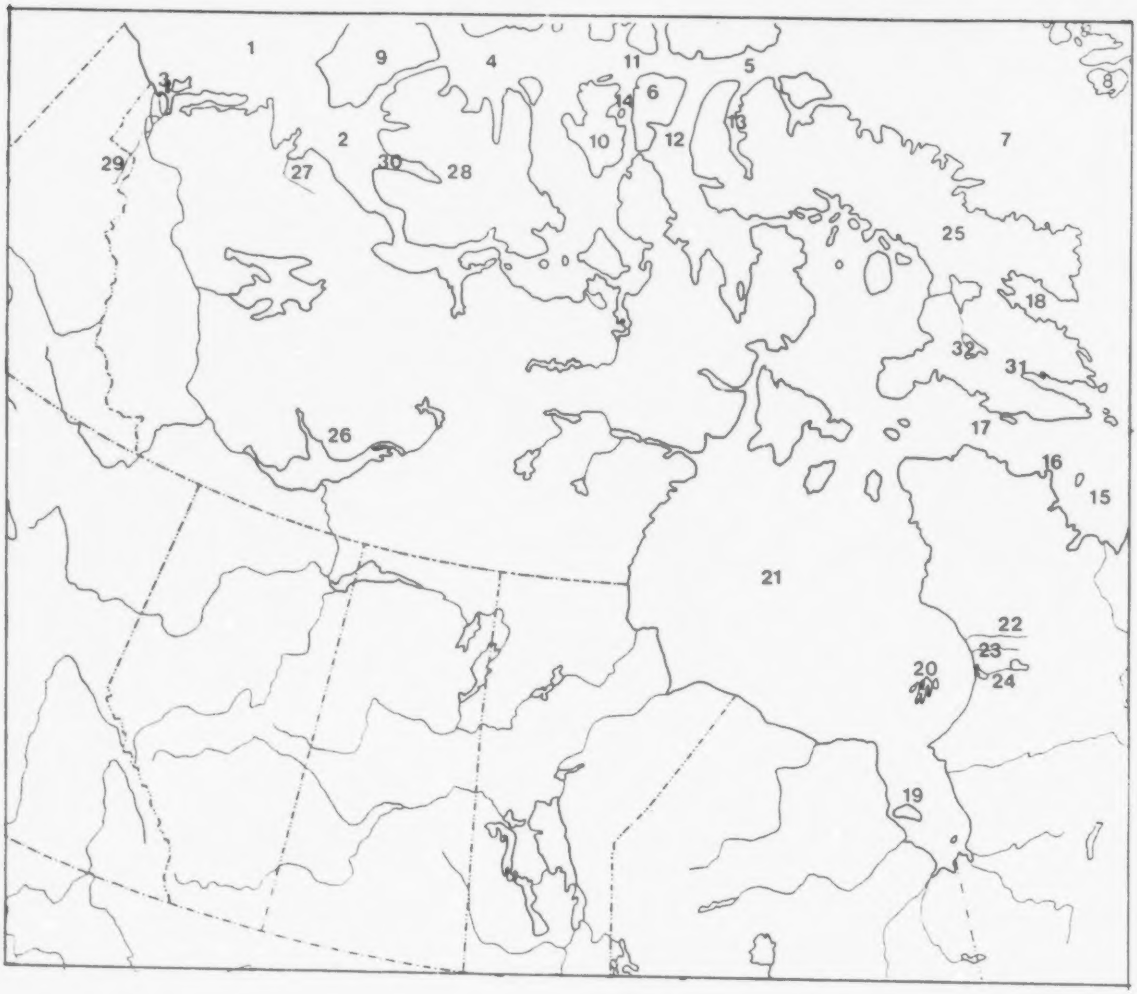
No interest in fishing this location. Status of stock unknown.

61. Unnamed Lake and River (Styrmann Is.)	not opened	not opened	900 (800)

No interest in fishing this location. Status of stock unknown.

62. Unnamed River	not opened	2 500/NA	2 500 (2 200)

This Igloolik winter fishery has not been fished commercially for several years. A small sample (N = 32) was obtained in August, 1984. The predominance of large, old charr in the sample indicated that exploitation was probably light. Annual domestic harvest is estimated as 250 kg.



Key locations:

1. Beaufort Sea
2. Amundsen Gulf
3. Mackenzie Delta
4. Vicount Melville Sound
5. Lancaster Sound
6. Somerset Is.
7. Davis Strait
8. Disko Is. (Greenland)
9. Banks Is.
10. Prince of Wales Is.
11. Barrow Strait
12. Prince Regent Inlet
13. Admiralty Inlet
14. Peel Sound
15. Ungava Bay
16. Quaqtaq
17. Hudson Strait
18. Cumberland Sound
19. James Bay
20. Belcher Is.
21. Hudson Bay
22. Nastapoka R.
23. Little Whale R.
24. Great Whale R.
25. Baffin Is.
26. Yellowknife
27. Hornaday R.
28. Victoria Is.
29. Rat R.
30. Prince Albert Sound
31. Sylvia Grinnel R.
32. Nettilling Lake

Figure 1. Geographic key to locations described in the stock reports.

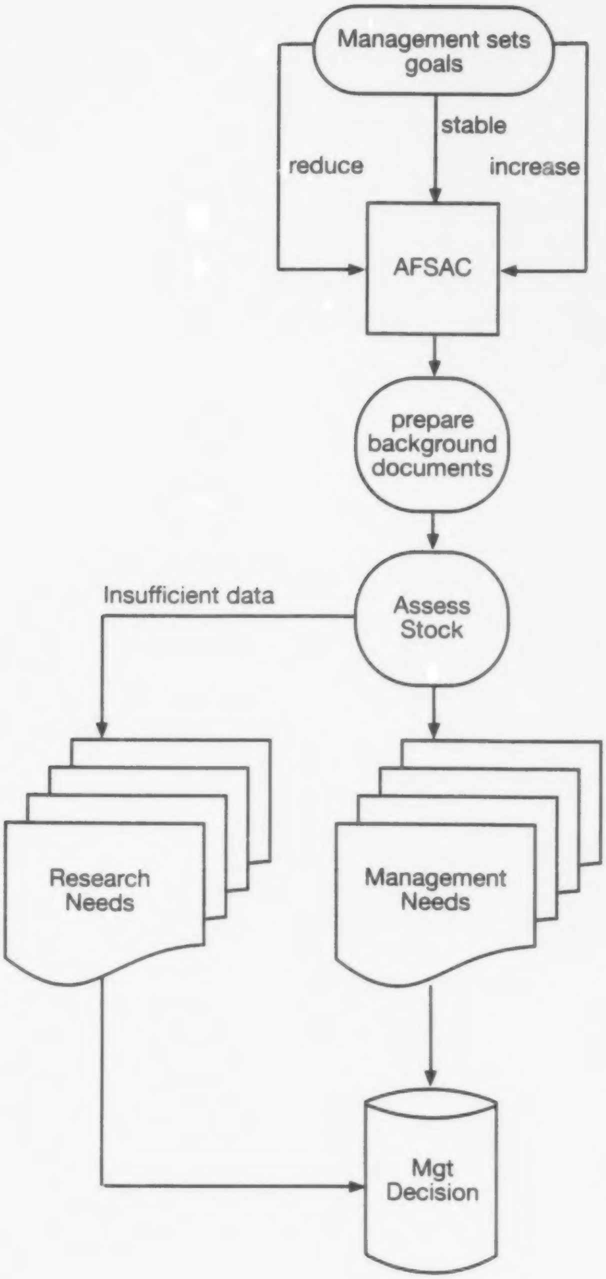

Management sets goals
stable
reduce
increase
AFSAC
prepare background documents
Insufficient data
Assess Stock
Research Needs
Management Needs
Mgt Decision

Figure 2. Flow chart of AFSAC process. Request for stock review comes from management to AFSAC. AFSAC requests preparation of background documents which assess the stock and make recommendations for management actions and research needs. Managers make decisions about management actions based on input from AFSAC as well as other information sources.

Appendix 1. List of AFSAC Background Documents for 1989/90 and 1990/91.

1989/90 Background Documents

89/90-01	Beaufort Sea Beluga. T. Strong.
89/90-02	Ungava Bay and Eastern Hudson Bay Beluga. R. Reeves and E. Mitchell.
89/90-03	Review of the Estimated stock size for the Western Arctic Bowhead Whale. S. Innes.
89/90-04	Lake Whitefish: Chitty Lakes. E. Gyselman.
89/90-05	Ringed Seal. S. Innes.
89/90-06	Lancaster Sound Beluga Whales. S. Cosens and R. Stewart.
89/90-07	Biology of Iceland Scallops and Its Implications for the Management of an Arctic Fishery. R. Crawford and C. Hudon.
89/90-08	A Preliminary Analysis of the 1988 Cumberland Sound Iceland Scallop Fishery. R. Crawford and D. Pike.
89/90-09	Update of the Baffin Island Turbot Fishery. R. Crawford.
89/90-09A	Greenland Halibut Allocation: Baffin Region. D. Pike.
89/90-10	Stock Status of Arctic Charr in the Kagluk R., N.W.T. P. Lemieux.
89/90-11	Stock Status of Arctic Charr in the Rat R., N.W.T. P. Lemieux and A. Kristofferson.
89/90-12	Stock Status of Arctic Charr in the Hornaday R., N.W.T. P. Lemieux and A. Kristofferson.
89/90-13	Arctic Charr: Keewatin. A. Kristofferson.
89/90-14	Annual Summary Arctic Charr in N.W.T. A. Kristofferson.
89/90-15	Framework for making management and research recommendations by the AFSAC Marine Mammal Subcommittee: objectives, data requirements and definitions of terms. S. Cosens, S. Innes, P. Richard, R. Stewart and T. Strong.

1990/91 Background Documents

90/91-01	Bearded Seal. H. Cleator
90/91-02	On the Davis Strait/Cumberland Sound Greenland Halibut (*Reinhardtius hippoglossoides* Walbaum): Its Biology and its Fisheries. R. Crawford.
90/91-03	Stock Status of Arctic Charr in the Naloagyok River, Northwest Territories. P. Lemieux
90/91-04	Stock Status of Arctic Charr in the Kagloryuak River, Northwest Territories. P. Lemieux.
90/91-05	Arctic Charr of the Sylvia Grinnel River. D. Pike and L. Dahlke.
90/91-06	Annual Summary Arctic Charr in N.W.T. A. Kristofferson.
90/91-07	Eastern Hudson Bay Beluga. T. Smith.
90/91-08	Commercial Fishing Potential for Searun Arctic Charr Koukdjuak River and Nettilling Lake, Northwest Territories. A.H. Kristofferson, R.D. Sopuck, and D.K. McGowan.

Appendix 2. List of AFSAC Background Documents by species from 1986 to 1990/91.

SPECIES	BACKGROUND DOCUMENT #	TITLE/AUTHOR(S)
FISH SUBCOMMITTEE		
Arctic Charr	86/87-10	Status Report on Searun Arctic Charr Stocks in the Northwest Territories. A. Kristofferson, G. Low, L. Dahlke, E. Gyselman and L. Johnson.
	87/88-01	Stock Assessment for Arctic Charr in the Steensby Inlet Area, N.W.T. M.M. Roberge.
	87/88-05	Stock Status of Arctic Charr in the Firth River, Yukon Territory. A.H. Kristofferson and R.F. Baker.
	87/88-06	Stock Status of Arctic Charr in the Babbage River, Yukon Territory. A.H. Kristofferson and R.F. Baker.
	87/88-07	Stock Status of Arctic Charr in the Rat River, Northwest Territories. A.H. Kristofferson and R.F. Baker.
	87/88-08	Stock Status of Arctic Charr in the Big Fish River, Northwest Territories. A.H. Kristofferson and R.F. Baker.
	87/88-09	Stock Status of Arctic Charr in the Hornaday River, Northwest Territories. A.H. Kristofferson.
	87/88-10	Stock Status of Arctic Charr in the Kuuk River, Northwest Territories. A.H. Kristofferson.
	87/88-11	Stock Status of Arctic Charr in Freshwater Creek, Northwest Territories. A.H. Kristofferson, G. Carder, D.K. McGowan and G. Low.
	87/88-12	Recommended Commercial Fishing Quotas in the Northwest Territories 1988/89. A. Kristofferson, L. Dahlke and G. Low.

88/89-09	Quota Recommendations for Commercial Fisheries of Anadromous Arctic Charr, Northwest Territories, 1989/90. A.H. Kristofferson, G. Low, D. Pike and B. Stewart.
88/89-10	Stock Status Report of Arctic Charr Commercial Fisheries of Cambridge Bay, Northwest Territories. A.H. Kristofferson, D. McGowan, G. Carder and G. Low.
89/90-10	Stock Status of Arctic Charr in the Kagluk R., N.W.T. P. Lemieux.
89/90-11	Stock Status of Arctic Charr in the Rat R., N.W.T. P.Lemieux and A. Kristofferson.
89/90-12	Stock Status of Arctic Charr in the Hornaday R., N.W.T. P. Lemieux and A. Kristofferson.
89/90-13	Annual Summary Arctic Charr in N.W.T. A. Kristofferson.
89/90-14	Arctic Charr: Keewatin. A. Kristofferson.
90/91-03	Stock Status of Arctic Charr in the Naloagyok River, Northwest Territories. P. Lemieux.
90/91-04	Stock Status of Arctic Charr in the Kagloryuak River, Northwest Territories. P. Lemieux.
90/91-05	Arctic Charr of the Sylvia Grinnel River. D. Pike and L. Dahlke.
90/91-06	Annual Summary Arctic Charr in N.W.T. A. Kristofferson.
90/91-08	Commercial Fishing Potential for Searun Arctic Charr, Koukdjuak River and Nettilling Lake, Northwest Territories.

Walleye	86/87-06	Status of the Walleye Utilizing the Hay River, Northwest Territories. M.M. Roberge and G. Low.
	86/87-07	Status of the Walleye Stock from Tathlina Lake, Northwest Territories. M.M. Roberge and G. Low.
	86/87-08	Status of the Walleye Stock from Kakisa Lake, Northwest Territories. M.M. Roberge and G. Low.
	86/87-09	Status of the Walleye Stock Utilizing the Mosquito Creek, Northwest Territories. M.M. Roberge and G. Low.
	87/88-04	The Walleye of Mosquito Creek, Northwest Territories. M.M. Roberge.
Lake Trout	86/87-05	Status of Lake Trout in Great Bear Lake, N.W.T. G. Yaremchuk and M.M. Roberge.
		Update on the Status of Lake Trout in Great Bear Lake, Northwest Territories. M.M. Roberge.
Broad Whitefish	87/88-02	Interim Report on the Status of the Broad Whitefish (Coregonus nasus) Stocks of the Lower Mackenzie Basin. R.F. Baker.
	88/89-01	Status Report on Broad Whitefish Stocks of the Lower Mackenzie Basin, Northwest Territories. R.F. Baker and J.D. Reist.
Lake Whitefish	89/90-04	Lake Whitefish: Chitty Lakes. E. Gyselman.
Arctic cisco	88/89-02	Arctic cisco, Coregonus autumnalis, in the Mackenzie River Basin, Stock Status Report. W.A. Bond and J.D. Reist.

Greenland Turbot	88/89-04	Greenland Halibut of the Inshore Eastern Arctic. R. Crawford and L. Dahlke.
	89/90-09	Update of the Baffin Island Turbot Fishery. R. Crawford.
	89/90-09A	Greenland Halibut Allocation: Baffin Region. D. Pike.
	90/91-02	On the Davis Strait/Cumberland Sound Greenland Halibut (Reinhardtius hippoglossoides Walbaum): Its Biology and its Fisheries. R. Crawford.
Iceland Scallops	88/89-07	Iceland Scallops in the Eastern Arctic. R. Crawford.
	89/90-07	Biology of Iceland Scallops and Its Implications for the Management of an Arctic Fishery. R. Crawford and C. Hudon.
	89/90-08	A Preliminary Analysis of the 1988 Cumberland Sound Iceland Scallop Fishery. R. Crawford and D. Pike.

MARINE MAMMALS SUBCOMMITTEE

Beluga	86/87-11	Status of the Sub-arctic Beluga (Delphinapterus leucas) Populations in the Northwest Territories and Northern Quebec. P.R. Richard.
	87/88-13	Status Report: Beaufort Sea Beluga. J.T. Strong.
	88/89-06	Status of the Western Hudson Bay Beluga (Delphinapterus leucas) Populations. P.R. Richard.
	88/89-08	Stock Status Sheet Southeast Baffin Beluga (Delphinapterus leucas). R. Stewart.
	89/90-01	Beaufort Sea Beluga. T. Strong.
	89/90-02	Ungava Bay and Eastern Hudson Bay Beluga. R. Reeves and E. Mitchell.

	89/90-06	Lancaster Sound Beluga Whales. S. Cosens and R. Stewart.
	90/91-07	Eastern Hudson Bay Beluga. T. Smith.
Narwhal	86/87-13	Status of the Narwhal, *Monodon monoceros*, in Canada. J.T. Strong.
	87/88-14	Northern Hudson Bay Narwhal Stock. P.R. Richard.
	88/89-05	Status of the Narwhal, *Monodon monoceros*, in Canada. J.T. Strong.
Bowhead	88/89-11	Stock Status Report on Canadian Arctic Bowhead Whales. E.D. Mitchell.
	89/90-03	Review of the Estimated stock size for the Western Arctic Bowhead Whale. S. Innes.
Walrus	86/87-12	Status of Walrus (*Odobenus rosmarus*) in Canada. P.R. Richard.
Ringed Seal	87/88-15	Status of the Ringed Seal in Canada. M.C.S. Kingsley.
	89/90-05	Ringed Seal. S. Innes.
Bearded Seal	90/91-01	Bearded Seal. H. Cleator.
GENERAL TOPICS		
	86/87-01	Arctic Fisheries Scientific Advisory Committee, Terms of Reference and Operating Procedures, July 1986. Position Paper on the Arctic Fisheries Scientific Advisory Committee, April 1987.
	86/87-02	Studies on the Systematics and Population Structure of Arctic Marine, Anadromous, and Freshwater Fishes. A Justification and Statement of Need for Research. J.D. Reist.

86/87-03	Exploitation of Arctic Fishes. R. Crawford.
86/87-04	Limnology, Oceanography and Fisheries Research. The View from the Arctic Window. L. Johnson.
88/89-03	Review of Keewatin Lakes. L. Johnson.
89/90-15	Framework for making management and research recommendations by the AFSAC Marine Mammal Subcommittee: objectives, data requirements and definitions of terms. S. Cosens, S.Innes, P. Richard, R. Stewart and T. Strong.

Appendix 3. Glossary of terms used in the report by the AFSAC Marine Mammals Subcommittee for 1989/90 and 1990/91. The following definitions have been agreed upon by the AFSAC Marine Mammals Subcommittee and apply to the report by that subcommittee contained in this manual report, as well as future reports by AFSAC.

Age at first ovulation: This reproductive parameter which is a more precise measure of age of maturity should be estimated with some measure of central tendency, variance and sample size. The author should describe the technique used to identify age and ovulations and discuss biases. Normally it is expressed in years and often a range is most accurate.

Age at first pregnancy: This parameter should be estimated with some measure of central tendency, variance and sample size. The technique used to identify age and pregnancy should be described and biases discussed.

Age structure of population: This is estimated from the frequency distribution age classes, usually individuals sampled from the stock. The ageing method should be identified. Authors must also discuss the sex and age bias of the sampling procedure so that interpretation of differences between samples is not confounded by differences in sampling procedure.

Fatness: This variable is estimated by measuring blubber thickness and amount of core fat. Gender, reproductive status (e.g. pregnant, lactating) and nutritional status (e.g. fasting) of individuals and the date samples were collected must be included. This is an important variable that is not measured and reported on in all samplings, however, it should be.

Finite rate of increase (λ): This variable is population growth rate calculated from age specific fecundities (the number of female calves born in one year per female of a given age class in the previous year) and survival rates (the percentage of individuals in any given age class that survive to enter the next age class) (Reilly and Barlow 1986) and expressed as a percentage of total population per year. Values used for narwhal and belugas have been derived from population models (Beland et al. 1988; Kingsley 1989; Reilly and Barlow 1986). Those used for some pinnipeds, such as the ringed seal, have been derived from 'age at harvest' studies. Authors should indicate how estimate was derived.

Pregnancy rate: This is the percent of pregnant females relative to the total number of sampled adult females. The date when samples were collected should be included because the value of estimate will depend upon the time of year where samples were collected. Other variables such as birth rate or calving rate could also be reported but the method, date of the sample and a discussion of biases have to be included.

Stock: Cetacean stocks are identified by their areas of summer concentration, to avoid uncertainty about the degree of genetic mixing in the wintering area. Local declines of whales using particular estuaries suggest this to be a useful management approach (Reeves and Mitchell in press). Pinniped stocks may be similarly defined. For example, ringed seals are continuously distributed across the arctic but can be depleted on a local level, at least temporarily. The area of local depletion should therefore define the stock.

Stock distribution: The distribution or geographic range of the stock includes the summering, migration and wintering locations. Spatial and temporal overlap with other stocks should be identified, if known or suspected. Authors should indicate how stock identification has been carried out. Any terminology used to identify methods, e.g. body length or girth should be operationally defined such that data sets for different stocks can be readily compared by individuals not on the Subcommittee.

Stock size: The number of individuals in a stock is estimated using some measure of central tendency and an estimate of variance, such as a 95% Confidence Interval, calculated from surveys, mark-recapture or some other acceptable method. Authors should indicate whether the value includes a correction factor, its variance and how the correction factor alters the uncorrected estimate. Potential biases in sampling design or method should be identified.

Struck and lost rate: This variable is estimated by the total animals struck and wounded but not landed during a hunt, expressed as a percent of the total number of animals struck. Assuming that all animals struck and lost are removed from the population:

$$\text{landed animals} = \text{Total removal} - (\text{total removal} \times \text{loss rate})$$

This equation can also be expressed as:

$$\text{Total removal} = \text{landed} \times \frac{1}{1\text{-loss rate}}$$

A preferred measure of hunting loss is the 'killed and lost' rate, calculated in a similar way. The number killed must then be estimated by assessing whether a lost animal was mortally wounded or not. Whichever estimate is used must include some explanation of assumptions used in deriving the estimate. For example, are all animals struck and lost assumed to be removed from the stock?

Total Allowable Removal (TAR): The total number of animals that can be removed from a stock for any reason including harvest, live capture or scientific samples. With respect to harvesting, this number includes those animals landed and those struck and lost. This value is equivalent to total allowable harvest used previously by the Subcommittee, but more accurately denotes that landed and lost animals are included. For a management goal of a harvest that results in zero population decline, TAR is calculated by multiplying the current estimated stock size by the estimated finite rate of increase. To estimate TARs with varying levels of risk the following method should be used. Low risk: Lowest estimated stock size (derived from the Mean - 95% Confidence Interval) multiplied by the finite rate of increase; Medium risk: Mean stock size multiplied by the finite rate of increase; High risk: Highest estimated stock size (derived from the Mean + 95% Confidence Interval) multiplied by the finite rate of increase. Low risk TAR is considered to be unlikely to cause a decline in stock size whereas a high risk TAR is considered to be more likely to cause a decline in stock size.

Appendix 4. Glossary of terms used in the report by the AFSAC Fish Subcommittee for 1989/90 and 1990/91. The following definitions have been agreed upon by the AFSAC Marine Mammals Subcommittee and apply to the report by that Subcommittee contained in this annual report, as well as future reports by that Subcommittee for AFSAC.

Age at length = 0 - Theoretical age of fish when length is zero (t_o), calculated from von Bertalanffy growth equation:

$$l_t = L\infty \ (1-e-k(t-to)$$

or $t_o = \frac{\text{loge } (c/b)}{k}$ where $c = be^{kto}$

(t_o can be positive, negative or zero).

Asymptotic length/weight - Length (or weight) that an average fish would achieve if it continued to live and grew indefinitely (as t increases indefinitely, length (or weight) + ends L an asymptote). Usually represented by $L\infty$ or $W\infty$.

Body growth coefficient - exponent K in the growth equation:

$$L\infty = l_t = ce^{-kt}$$

$L\infty$ = asymptotic length

l_t = length at time t

c = constant with length dimensions

e = natural logarithm constant

t = time

Instantaneous total mortality (M) - ratio of number of deaths per unit of time to population abundance during that time.

Instantaneous rate of fishing mortality (F) - instantaneous total mortality rate multiplied by the ratio of fishing deaths to all deaths (also called rate of fishing and instantaneous rate of fishing).

Maximum Sustained Yield - largest average catch or yield that can continuously be taken from a stock under existing environmental conditions.

Recruitment - addition of new fish to the population which is vulnerable to a particular kind of fishing method. Occurs by growth of individuals from smaller size categories.

TAC - Total allowable catch (quota).

Yield-per-recruit - yield (catch) of a fishery per number (or unit weight) of recruits entering the fishery.

Appendix 5. Recommendations for Future AFSAC report formats made by the AFSAC Fish Subcommittee, March 1990.

A) Reports to be submitted to AFSAC termed background documents. These reports can be prepared in one of two formats.

1. Background reports:
   - current summaries of relevant information, for example, this year's report on the biology of the Iceland scallop;
   - can be background information on a species, on the management procedures for a species, or on a research project with objectives relevant to management;
   - format should be very flexible;
   - should have an abstract for inclusion into Subcommittee's summary report (see below);
   - should include author's recommendations regarding research, future management directions on specific management recommendations.

2. Stock status reports - can be for single or multiple stocks of the same species. They should contain information under the following headings:
   a) Background
      Stock definition
      Stock size
      Vital parameters
      Current harvest
      Other impacts
   b) Major Issues
   c) Assessment and Prognosis
   d) Recommendations
      - for management of the stock
      - for further research required.

   The format of a stock status report should also include a standard title page, an introduction and literature cited.

B. Reports prepared by the AFSAC Subcommittees. Subcommittees would prepare from these two types of reports received, two types of summary reports as follows:

1. Background report summaries - these would consist of summaries of background reports.
   - The summary would include the abstract of the background report.
   - The summary would also include the subcommittee's recommendations for management, research and the timing of the next AFSAC review.

2. Stock status sheets - these would consist of summaries of stock status reports, incorporating the information under the headings as described in A.21 and containing the management and research recommendations as endorsed by the entire Subcommittee. Again, there would also be a recommendation on the timing for the next review of the stock by AFSAC.